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ABSTRACT

Included in this publication are 20 papers related to teaching chemistry in two-year colleges. The papers are presented under the following categories: Innovative Teaching; Allied Health; Chemistry as a Career; Chemical Technology; and Chemistry for Non-Science Majors. Most of the papers were presented at two meetings (Regina and Houston). (RH)

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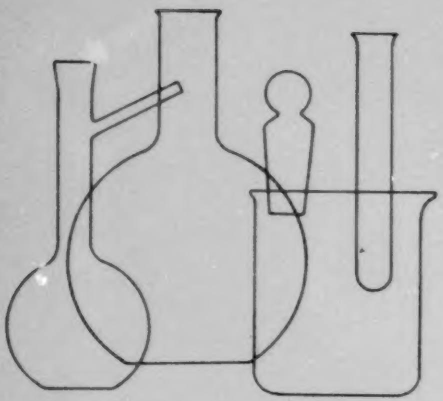

CHEMISTRY
IN THE
TWO-YEAR COLLEGE

VOLUME XIV 1975

2YC₃
COMMITTEE ON CHEMISTRY IN THE TWO-YEAR COLLEGE
DIVISION OF CHEMICAL EDUCATION · AMERICAN CHEMICAL SOCIETY

SE 022 458

Foreword

Volume XIV of Chemistry in the Two-Year College includes articles from the Regina and Houston meetings. We expressed thanks to all who helped with these conferences in Volume XIII. The Regina meeting was under the co-chairmanship of Jans Diemer and Graham Welch with Douglas Jardine as the Proceeding Editor. The vice-chairman of the Southern Region was Edith Bartley, who organized the Houston conference. The Proceeding Editor was John Mitchell.

The Chairman of the $2YC_3$ for the year 1975 was Cecil Hammond from Penn Valley Community College in Kansas City. The first meeting of 1975 was on his home campus, where Cecil and his staff were responsible for local arrangements. Henry Pacheco from Penn Valley was the coordinator for exhibits. We must remember this important area of each conference, since this is our opportunity to see new books and apparatus on the market. Our thanks goes to these industrial sponsors who support us with their membership and their exhibits.

Ralph Burns from East Central Junior College was the Midwest Region vice-chairman. He included sessions on Chemistry Related to Careers, Projects of Two-Year College Instructors and Quality Programs in Chemistry. These were fine sessions and Ralph did a fine job in organizing the meeting.

Helping conduct the Concurrent Section meetings were Bill Wyatt, Alvin Blough, Bill Griffin, Dorothy Schultz, David Hittel, Jack Sosinsky, Fred Redmore and John Winkelman. Editor of the Conference was Katherine Weissman. Kathy did a grand job in collecting the papers and getting them to us. This fine work is especially appreciated by the editors!

The Regional vice-chairman of the Eastern Region was Mother M. Bohdonna from Manor Junior College. It was with her leadership that special programs including "Allied Health Programs Interface" and Special Techniques in Chemistry called "Chemical Education on the Move" were developed.

Sister M. Jonathon was the exhibits coordinator and local arrangements chairman. The conference secretaries were Stephanie Levick and Michele Fischuk. Conference Editor was Howard A. Ayer from Franklin Institute of Boston. He did a beautiful job of getting the papers to us also.

All of us who benefit from these papers express our thanks to all of these people who have given their time and energy to make our conferences and journal possible.

Jay & Ellen Bardole
Editors

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The Learning Systems Approach to the Teaching of General Chemistry

Rod O'Connor
Texas A & M University
College Station, Texas 77834

Presented as a Quality Porgram in Chemistry to the Forth-Third Two-Year College Chemistry Conference, Penn Valley Community College, Kansas City, Missouri, February 8, 1975.

A great deal of attention has been focused in recent years on "self-paced" instruction. While many of the ideas of such programs are excellent, experience has revealed some problems. The use of highly specific, "small step", objectives has often resulted in situations better described as "training" than as "learning". Many of the students in first year chemistry are not sufficiently experienced or motivated to accept the responsibility of true "self-pacing". In addition, much of the excitement of chemistry has proved difficult to impart outside of the framework of a "lecture" situation. These and other problems are magnified with large chemistry classes. Since my own experience has been primarily with large programs, I have been working for several years to improve the instructional format of such courses and the Learning Systems Approach has evolved from this work. Although our use of this system is geared to large classes, many aspects of the approach may prove useful in smaller programs as well.

The Learning Systems Approach is based on two postulates:

(1) Students will work most efficiently when supplied with appropriate guidelines for study.

(2) Students learn in different ways so that alternative learning resources are needed.

The study guidelines provided include objectives, supplied in the text and supplemented or modified by the instructor, which delineate clearly the kinds of things students should learn or be able to do. The attempt is made to frame these objectives in sufficient detail to direct the student's study efforts without being so specific as to encourage the "training" mode. Exercises permit the student to practice in the areas indicated and Self-Tests then allow him to evaluate his own progress and identify areas needing further study or clarification from the instructor. In addition a study-pacing schedule is provided to help the student form an efficient learning pattern and use of this schedule is encouraged by regular homework assignments which may be turned in for credit.

There is no doubt that students do learn in different ways. For some, the textbook alone is sufficient. Most, however, require additional resources. Our experience, and that of many others, suggests that the lecture, with all its reputed shortcomings, is still the best single teaching mode for the needs of most students. Our lectures attempt to clarify the more difficult concept and problem situations, to illustrate chemical ideas in a framework of relevant applications, and to inject the "human element" through classroom interaction. In cases where lectures go beyond the textbook objectives, it is important to make available to students the statements of added or modified objectives and copies of lecture notes (or lecture tapes) so that their resources are not limited by their notetaking skills, which are rarely well-developed in their first year courses. We encourage lecture attendance, but do not require it, since we want the student to have the freedom to select the learning resources best suited to his own needs. Most of our students do attend lectures regularly and many attend more than one section to obtain alternative viewpoints on concepts and problems. We have available a well-equipped Autotutorial Center for students desiring a more personalized learning pace than lectures provide or supplementary study aids for special needs. We strongly encourage students to ask questions in class and to seek special help when they encounter concepts or problems difficult for them to grasp. To ensure that help is available when needed, our graduate assistants keep regular office hours and we provide a Professor-Tutorial program in which our senior faculty volunteer scheduled times to visit with students (30-35 different hours per week). We also hold weekly review/discussion sessions in evening hours for students desiring additional group-learning activities. Laboratory work offers the kind of "hands-on" experience which has always been one of the more important learning modes in chemistry.

The objectives stated in the textbook relate to each unit of material. In our programs we further differentiate our total objectives into three categories: short-range (those that indicate comprehension of some rather limited topic as demonstrated by performance on the corresponding Unit Self-Test); and long range (those that provide background and major ideas for extensive coverage of a number of topics). Short-range objectives are usually not covered on EXAMS. The specification of medium-range and long-range objectives is provided by PRACTICE EXAMS and PRACTICE COMPREHENSIVE (FINAL) EXAMS, with associated review outlines.

Our experience with the Learning Systems Approach has been good. We believe the evidence indicates that students are learning chemistry better and enjoying it a great deal more than under more traditional programs. Our course presents a broad spectrum of chemical science and students sometimes feel that we are going a bit fast. With the reinforcement and review applications provided by later Units, however, the end result has proved generally satisfying to students and participating faculty. We find that grades run relatively high, but these seem to be justified by performance levels in subsequent courses. The Learning Systems Approach requires a considerable effort, both by students and faculty, and like any teaching program, a continuing evaluation and revision. We believe that those who put forth this effort can enjoy a rewarding experience in learning.

Chemistry for Apocalyptic Times

John Hill
University of Wisconsin
River Falls, Wisconsin 54022

Presented as a Quality Program in Chemistry to the Forty-Third Two-Year College Chemistry Conference, Penn Valley Community College, Kansas City, Missouri, February 8, 1975.

For ages, there have been some who have predicted dire things for the human race. The present apocalyptic age is nothing new in human history, but it is perhaps unique in that it follows upon a period of almost unbridled optimism. From the 16th century to the middle of the 20th, science was a most optimistic way of looking at the world. Now it seems that even science has turned sour, and many of its practitioners preach the darkest pessimism. Some predictors of the apocalypse are listed in the table.

Prophet	Theory	Prediction
John S. Mooney (the author's grandfather)	Big things happen every 2000 years	The end of the world (second coming of Christ) in the year 2000
Rachel Carson (biologist, writer)	"Pesticides" are really biocides	Continued use (and misuse) of pesticides would lead to destruction of all life
Paul Ehrlich (biologist, writer)	People will use ever stronger pesticides	The end of life in the oceans by 1979, with the extinction of land organisms shortly thereafter.
Dennis Meadows, et al. (MIT scientists)	Computers can be used to predict our future.	Depletion of natural resources, build-up of pollutants will lead to a catastrophic drop in human population by the middle of the 21st century.

The scientific establishment winked at each other knowingly about fundamentalists like my grandfather. The roundly denounced Rachel Carson and Paul Ehrlich. But the MIT group got their attention. Even the business community began to listen. Why? Probably because of the prestige of the institution (MIT), and because of the expensive, sophisticated instrumentation that they used to predict the obvious: continued expansion is not possible on a finite planet.

Population has been growing at an exponential rate. The doubling time for a population can be calculated using the "Rule of 70".

$$\text{Doubling time (years)} = \frac{70}{\text{growth rate (\% per year)}}$$

At the current growth rate (1.8%), the doubling time is 39 years. Will the population of planet Earth double by 2013? No way!

The "Rule of 70" is derived from the first order rate equation:

$$\log X = \log X_o - \frac{kt}{2.30}$$

or

$$\log \frac{X_o}{X} = \frac{kt}{2.30}$$

For doubling, $X = 2X_o$

$$\log \frac{X_o}{2X_o} = \frac{kt}{2.30}$$

$$\log 0.5 = \frac{kt}{2.30}$$

$$0.301 = \frac{kt}{2.30}$$

$$t = \frac{.693}{k}$$

Change k from a fraction to percent by multiplying by 100:

$$t = \frac{69.3}{\%} \cong \frac{70}{\%}$$

A most striking thing about exponential growth is that one goes from half-full to full in one growth period (i.e., in one growth period.)

The "Rule of 70" can also be applied to the growth of an industry (e.g., electric power generation) or to the depletion (increase in the use of) of a natural resource. If we double our use of coal (for example) every 25 years, we will go from a situation in which half our reserves are left to one in which none are left in 25 years. That won't really happen, because as it gets scarcer, coal will get more expensive and our rate of use will decline. The point is that growth can't go on forever.

For students who get hung up on mathematics, even that of simple division, exponential growth (or depletion) can be demonstrated rather dramatically by burning a candle. Light one, partially hidden, and ask the student how long it will last. (Our fossil fuel reserves are partially hidden, leading to varying estimates of how long they will last). Now light the candle at both ends. How long will it burn? Obviously, only half as long. Now cut it in two and light all four ends. Repeat the process -- in your imagination -- until you have billions of tiny candles. Show how rapidly these would burn by throwing some lycopodium powder into a bunsen flame. Whoosh! ! It's all gone.

One can also use the candle-lycopodium demonstration to illustrate the effect on concentration on the rate of chemical reactions (see Instructor's Guide to Chemistry for Changing Times, 2nd edition, p. 46).

The laws of thermodynamics have a good deal to say about the end of things. The first law says that energy is conserved in chemical reactions. Energy can be changed from one form to another. However, it is most important to note that some of the energy in any such conversion always winds up as heat. Consider the light bulb, a device for converting electrical energy to light energy. Only 1-10% of the energy is actually converted to light. The rest is waste heat. Maybe we ought to call them "heat bulbs."

The first law tells us that it's gonna get warm -- if we continue to increase the use of energy. Ted Brown (Energy and the Environment, Charles E. Merrill Publishing Co., 1971) estimates that the current rate of growth in energy use (doubling time worldwide, 25 years), we will reach our limit in a couple of centuries. Local effects are already well documented and will be quite pronounced by the year 2000.

The second law says that energy flows spontaneously from hot to cold. We can reverse the trend (that's what refrigerators are all about), but only at the cost of energy (the electric bill). That's what life, and science, and civilization are all about. The second law tells us that we can win some bottles, but in the end we will lose the war. It's gonna get mighty cold -- several billion years from now. To put it briefly, then the first law says we are going to make things warm in the near future, knowing full well (from the second law) that the end of the universe will be at some uniform low temperature.

The second law also states that there is a natural tendency from order to disorder. Again, we can reverse this trend. Again, the cost is energy. Take a new deck of cards. They are arranged in perfect order. Throw them out around the room. The cards can be put back in their former ordered state, but the cost is the expenditure of energy -- bending, stooping, squatting, sorting.

Alternatively, take a piece of copper. In nature, there used to be uncombined elemental copper. The copper atoms in the metal are highly ordered. Dissolve the copper in nitric acid. The copper atoms in solution are much less ordered. We can order them again -- e.g., by passing electricity through the solution, but it takes energy. Think how much more energy it would take to get the copper back after I pour the solution down the drain and it goes to near infinite dilution in the ocean. Then think what we are doing with phosphates. Polluting lakes may be the least of our problems.

There is still another natural law -- the law of diminishing returns-- which derives from the second law. It takes energy to get energy. There is a lot of potential oil in that shale, but the cost of getting it out -- in terms of water, environmental disruption, or even in terms of energy input -- may be more than it is worth. There is enough thorium in Vermont granite to provide centuries of nuclear fuel. The only trouble is the stuff is so dilute that it takes more energy to concentrate it than we can get back out of it by fission. We are fast approaching the limits of diminishing returns with several minerals. We had better keep it in mind as we look for new sources of materials and new sources of energy.

To avoid the apocalyptic end that many predict for us, we must be mindful of physical and chemical laws. They will undoubtedly be more vital to our survival than governmental laws. As teachers, we have the duty to provide our future citizens with the unique insights that chemistry gives us toward understanding the natural world. To fail in that duty may speed us on our way toward an apocalyptic end.

Individualized Instruction: A Learning Experience for the Teacher

Graham Orpwood
St. Lawrence College of Applied Arts and Technology
Kingston, Ontario

Presented to a Symposium on the Old and New Approach to Chemical Education at the Fortieth Two-Year College Chemistry Conference, University of Saskatchawan, Regina, Saskatchawan, June 6, 1974.

Course design has been said to be a process of optimisation of students, teacher(s) and learning materials; and in every teaching situation there are these three unique elements at least. Those of us who design courses are seeking for the environment where the teacher can cause the students to learn the subject matter as effectively as possible. Because the elements in a given situation are unique, the design or prescription must also be unique. There are many pitfalls awaiting those who ignore this fact.

An abundance of plans and pre-packaged methods are on display on the educational supermarket shelf; audio-tutorial methods, PSI or Keller plan, IPI (individually prescribed instruction) and many others. All have well-documented description, some impressive-looking results and a good following of devotees. But herein lies a danger. Methods and course designs are not necessarily transferable. Direct transfer of another's ideas can turn out to be both disillusioning and frustrating. Re-invention of the wheel is not always wrong as some would have us think. A course design is a very personal expression of one's own creativity as a teacher.

Having stated that, it may seem incongruous that I should presume to discuss the experiences that I have had with individualised instruction in Chemistry. However that is not so, as I could have done nothing without the help and advice of colleagues both at my own institution and elsewhere. But the "Orpwood plan" is not the 'Keller plan' though it borrows from it, nor do I commend it to you as the answer to your needs. There may be some ideas that arise, however, which will be useful in shaping your own unique prescription.

The course that I teach is one in General Chemistry for first year students in Chemical and Allied Health Technologies. It is divided into modules or units, defined in terms of behavioural objectives. The student must demonstrate mastery of each unit before passing on to the next. On each unit there is a video-taped lecture and a cassette with printed worksheet for take-home study (these being duplicates of the video-tape). The student also has a manual or study guide containing the objectives in detail, assignment details and hints on how to proceed.

The students have seven hours a week scheduled for classes in Chemistry and the teacher is in attendance during those hours in the Independent Learning Centre, a part of the College Resource Center, where there are carrels equipped with necessary equipment as well as seminar rooms and other normal Library facilities. We find that this degree of structure in the course is a good motivator for student attendance. It does not, of course, preclude the use of the materials at any other time that the Resource Centre is open (some 75 hours a week in term-time, including weekends). The activities during the scheduled hours are very varied. Simultaneously there will be individual tutorials, group discussions, tape-viewing and note-taking. Students will be writing tests, having them marked, writing assignments or even receiving personal counselling. I have found that a teacher-student ratio of up to 1 to 30 is possible on this basis. We have not as yet used student proctors.

In terms of achievement, it can be said that the results are reasonable encouraging. The 'pass rate' has increased from 61.4% (the average of the past three years) to 73.0% and the student comments were, in general, favourable. I do not want to dwell on these figures except to note that we are at least as well off as we were with the traditional system. It is in the area of the less easily measurable achievements that I believe that the greatest potential lies.

Individualisation has many potential components to it. Teaching has been described as 'providing the best possible environment for learning' and for every unique student that environment will be unique. Let us consider some of the ways in which this ideal may be achieved, using individualized instruction.

1. Self-pacing: Students' abilities to pace themselves vary considerably. Some regard it as a challenge and get ahead. Others will make it to the end with encouragement and prodding. Still others, as our experience has shown, will procrastinate indefinitely unless rigid deadlines are given. The solution to this, it seems to me, is to provide 'individualized pressure'.

2. Learning style: Some students learn best in a lecture class, some in small groups, and some on their own. Using a variety of techniques, we can both accommodate an individual to his own style and introduce him to new ones. Teachers have traditionally been suspicious of cooperative work, but frequently it may prove to be the most effective.

3. Learning materials: As many different materials as is compatable with economic considerations should be available to the student. The variations in preference here are as varied as the styles referred to earlier.

4. Work habits: These are enormously varied and it is only by individual tutorials that an improvement can be effected.

How does this all affect the teacher? First, he is freed from the normal tasks of conducting the class to do what no amount of audio-visual equipment can do. He must be whatever is needed to whoever needs him. He is a tutor and encourager, helper and prodder, stimulator and guide. This requires a special sense of commitment to the students as people.

Secondly, and I speak personally here, the teaching goals can undergo some radical changes. One becomes less concerned at the sole objective of teaching chemistry or whatever subject it may be, and begins to concentrate on other goals as well. These include helping the student recognize his own responsibility for his own education, to develop good work habits, to work cooperatively with others.

It has been said that the only worthwhile goals of an educational institution are to enable students to recognize what is worth learning and then how to learn it. It is my belief that the use of Individualized Instruction can help us move towards those goals.

Modules and Me

Penelope LeCouteur
Capilano College
North Vancouver, British Columbia

Presented to a Symposium on the Old and the New Approach to Chemical Education at the Fortieth Two-Year College Chemistry Conference, University of Saskatchewan, Regina, Saskatchewan, June 6, 1974.

The title of this paper sums up my feelings after spending the past year designing, writing and running a modularized SPL course at Capilano College. The college had originally embarked on 3 self-paced-learning courses; sociology, political science and chemistry. The concept was one of working in teams, perhaps a very modified version of the teams that produced the British Open University courses. Consequently, over a year ago, I started looking at the idea of an SPL course, working with another instructor who was an educational psychologist. After some initial planning and an overall review of what was required, it became obvious that the bulk of the work of organizing and writing the course would fall to the chemist--me! So I finally ended up working on the course by myself, but consulting with others where there was a need.

The course that I will be describing to you is based on some underlying principles or philosophies, some of which were present when I started and others of which became evident during the operation of the course. First, this SPL course would be an alternative to a regular course and not its replacement. Students will still have a choice as to whether to take a regular lecture-tutorial type section of first year chemistry or whether to elect to take chemistry by SPL. The two modes of instruction are not isolated systems. A student having trouble in a regular section could switch to SPL, an SPL student could sit in on a regular section, a student who wants to remain in a regular section, but was experiencing some difficulties with a certain part of the course could get the SPL modules for those parts. Flexibility for students are the key words.

The second basic principle that I followed when I designed the course was that I tried not to let the external requirements of the college dictate the way the course would be structured. By this I mean that I ignored such normal college conventions as withdrawal deadlines, semester starting times, normal grading systems, registration procedures, final exams, etc. In an SPL course many of these things become meaningless--you can't have a withdrawal date deadline if you are committed to true self paced learning. My idea was to come up with a course that would be arranged in the best possible way for student learning and then I'd fight the red-tape battles. At this stage it looks as if those battles won't occur, as our administration is being most helpful on these matters. Still I feel it is important not to let the traditional procedures of the college pressure you into not realizing the full possibilities of a new mode of instruction.

My third basic principle is one that I had vaguely thought of before I started designing the course, but which became very obvious during the running of the course and this principle is, that to be successful, any SPL course or individual learning packet must be personal. From my (admittedly limited) reading on this subject, I understand that one of the problems with SPL courses is a high drop out rate, often attributed to lack of personal contact between students and instructor. I think this need for personalization of a course is fairly self-evident and I also feel that it is this lack of personal contact that leads many instructors to doubt the effectiveness of a modularized, impersonal, self-instructional course. If you listen to students talking, you hear such comments as "Herbie's comparative literature course" and "Hannah's cell biology" --- students definitely relate the course to the instructor. I've been sent a number of published SPL modular courses and I'm not interested in using them as such. No matter how well written, they leave me cold --- they are impersonal or what's worse they try to be personal and fail because that's a contradiction in terms.

So, the course I have produced is a very personal one between my students and I, and is effective for me in my college. My course, as such, would not work for anyone else, but I feel that it is arranged (designed) in such a way that other instructors could adapt it for their courses with a minimum amount of work. By a personal course, I mean that it is basically the course that our college gives and makes references to place, things and people at Capilano. I have emphasized things that I regard as important and explained theories my way and used problems that I regard as good ones. Other instructors at Capilano would not have much adapting to do, but would still find it necessary to change some parts to make the course personal to them. This personalization of the course means that I have no intention of sending the modules to a publisher. As soon as you do this, you would cut out all the personal bits and add other topics that could give the course wider applicability, and then you would end up with a course that was not what you wanted and probably not what anyone else wanted. Also, once you have your modules committed to that form of print, you can't change anything and thus flexibility is gone.

This past academic year was to be for preparation of the modules, but I decided that I didn't want to run a self paced learning course unless I had first tested the material in the modules, so I had one section of first year chemistry which I used as an experimental section. This section was NOT self-paced,--the students were expected to keep up with other sections of first year chemistry. The class met once a week in order to collect the next module, hand in problems, and ask questions. If a particular module had been very poor and/or students were having trouble, I could then use that meeting time to explain or do problems. So the course last year was for testing the material in the modules and was not designed for testing the concept of self-paced learning; although the results of last year's test will effect the structure of next year's true SPL course.

There were 20 modules; 10 for each semester of a 2 semester freshman chemistry course. The main mode of instruction was print. I did briefly consider tape as a main mode but decided that it made more sense to stick to print as otherwise students would spend time making notes from tapes. One of the main problems students seem to have with chemistry is working out what is really important--what are the very basic ideas on which other things hang. For example, much of elementary kinetics hinges on the statement that "rate is proportional to concentration". I understand that, and you understand that, but students often do kinetics without really realizing that. I think that I always emphasize the important basic issues but in many cases students miss the main point in a whelter of other emphasized facts. So far, each module I put together what I termed a mainsheet which set out what were the important points of that module. Each module consisted of 5 parts:

Mainsheet)
Explanations)
Solved problems) the total known as the Mespo system
Problems)
Optional)

The mainsheet never gave details or explanations and was generally any one page, but it did direct the students to what they should be looking for in the Explanation part. The explanations took a number of forms. Nine of the modules had tapes that I made, plus diagrams and charts that went along with the tapes. One module included a video-tapes lecture on pH's which students were expected to go and watch in the college media center. Other explanations included references to the text book, my own written explanations, copied explanations from other sources, the occasional inclusion of a very simple experiment and use of a model kit included with the modules. Once a student had gone through the explanations he or she would check back to the Mainsheet to make sure that everything there was now understood. I suppose, if I used that sort of language, I would classify the Mainsheet as the behavioral objectives of each module, as it told the students what they were expected to know, understand and be able to apply from that module.

The 'S' and the 'P' of the Mespo system are Solved problems and Problems and are fairly self-explanatory. Detailed step-by-step solutions were given for the solved problems. Solutions to the problems without answers were available after these problems had been attempted. As far as possible, both sorts of problem sets were comprehensive, interesting and challenging.

The final part of the Mespo system is the Optional material and is for the student just that - optional. While this material was non-examination material, I hoped that use of the Optional section would increase a students' understanding and enjoyment of chemistry. Consequently, this often was the area in which the personal touch really was apparent. I included chemical jokes, cartoons, extra problems especially of the 'wierdo' type, references to other texts, essays on the social applications of chemistry, i.e. drugs, pollution, etc., an occasional science fiction story that demonstrated an idea discussed in the module, history of chemistry or science in general, old exam papers and anything else enjoyable and vaguely relevant.

This is the basis of the Mespo system but there are a few other comments I'd like to make. I wrote the scripts for the tapes and did my own performing under the direction of the College's Media Production Center. Without this type of professional help the tapes would not have been as good as they were. My students were adament in that they would not have wanted a professional voice reading the tapes. If another instructor was to run the course, it would not be much work to revise the scripts and have that instructor redo the tape - in accordance with the idea that an SPL course should be kept as personal as possible.

Our College was also fortunate in having a computer telephone terminal tied into Simon Fraser University's computer assisted instruction program. Thus a number of the modules directed the student to use the appropriate CAI section. The use of CAI was either stressed in the Optional material or was available as an alternative in the Explorations section, and this will be continued as the Mespo system will be used by students who have only limited physical contact with the College. But I do aim to encourage increasing use of the terminal by those students who have access to it.

For the final trial of the Mespo system I used ditto as a means of duplication and I keyed in the sections of the module to different colors. The Mainsheet is on blue, all Explanation material is on white, Solved problems are yellow, Problems on green and Optional is pink. I will be continually revising, rewriting and re-editing these modules and I intend to keep the color coding. I had originally thought of having the modules typed and printed at the College print shop, but I'm now seriously thinking of leaving the majority of each module as handwritten on ditto sheets. I feel the more formal I make the material, the less likely I am to review and revise each year and then I'd lose the flexibility which I think is the main benefit of the Mespo design. I am about to test this flexibility, as our chemistry faculty have decided to change to a different text. One thousand typed, printed and bound SPL courses already based on a certain text would have definitely been a factor to consider when thinking of changing texts, but these loose leaf Mespos did not exert any influence like that. So the whole Mespo course has to be re-referenced to a different text, but in this flexible form I don't expect that to be very time consuming.

I have no impressive lists of statistics to show that the Mespo system worked better than the usual lecture/seminar method. I don't even believe it is better - at least not in every case. What I do believe is that it can be a viable alternative for a number of students. My reasons for saying this are based on the sort of response I had from the students who took the course last year. The grade distribution was about the same as and the drop out rate slightly less than a regular section which I taught, but as the numbers involved are small, these figures are not statistically significant. The students in the Mespo section felt that they got a good deal. Comments such as "I like this method as it means I work when I feel in the mood for working", "I understand what's expected of me" and "I do more work in this course, but I get more out of it" were common. All of the students agreed that to be able to go at their own pace would be even better and a number of them started to self-pace themselves (as much as they could under the system). Although the group met only once a week and towards the end less than 1/2 of the class came to those weekly meetings as they had already collected the next module and handed in any assignment, I saw more of these students and got to know them better than students in my regular sections. The Mespo students had no hesitation in coming to my office, phoning me, stopping me in the hallway, coming and sitting with me in the coffee shop and pulling out the ubiguitous colored paper to ask questions and point out my mistakes. I had expected this sort of result from these students but was somewhat astonished at the response from students who were not in my classes. I'd told students in my regular sections that if they wanted any of the modules they had only to come and ask. Some of the other chemistry instructors had done the same and any student who did come and ask for a particular module ended up asking for others. One second year cell biology student who was having trouble with the thermodynamics in that course was advised by other second year students to get the first year thermodynamics modules.

The students have accepted this alternative mode of instruction and their acceptance has probably convinced some of the faculty of its value. To see numbers of students consistently working on chemistry and to listen to their enthusiastic response to the course did more to convince other faculty than all my comments.

So far this course has only been experimental and even then experimental in structure and content. This coming academic year we will offer self-paced first year chemistry. There will be no time limit for completion of the course; there will be no weekly meeting; students will seek help from the instructor as they require it and do exams when they are ready. As it will be self-paced, the concept of mastery will be incorporated. At least 70% will be required on every exam before it is considered that the student has mastered that section of the course. There will be no penalty imposed for not getting 70% on the first or any subsequent attempt and a student will be able to write these exams (after each 2 or 3 modules) any number of times.

There are, of course, problems involved in such a system. We are not yet equipped for self-paced laboratories nor are we equipped for portable laboratories for students who are not able to come to the college, but we are working on this problem. We will probably have a number of "laboratory weekends" throughout the semester, for students who for various reasons cannot make a usual once-a-week lab. Faculty workload is another problem. This type of course is NOT less work than the traditional lecture courses, in fact I have found it to be much more work. Capilano College has an exceptional work load committee, which amongst other things, will be looking into the problem of self-paced learning courses which continue for longer than an instructor's usual teaching semester. I'm sure that we will find many other problems once this course starts, but I'm also sure that the educational benefits to be gained will be enough incentive to find solutions to these problems.

Use of T.V. Modules in Chemistry

Jerry Gepner, Fred Nicolai, and Joseph Rogowski
Burlington County College
Pemberton, New Jersey 08068

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Small crews can pull off polished productions if they develop a show format that is flexible and well understood. At BCC we were faced with the problem of fully utilizing our color TV studio with little or no skilled support staff. As we investigated the problem and found that we could not rely on student help, we decided to assemble a production team with full-time staff members from other areas. Much of the economy realized in our later productions arises from the fact that the 3-man crew works well together. Each of the crew, director and two cameramen know the show format and are able to follow the action with much ease.

The show format is the key to our success. We do not use a talking face lecture method. Instead, we use a second person asking questions from the students' point of view. The students can identify with the questioner and not feel as if they are being talked at. Our first attempt with this new format came with the development of video modules in chemistry. How do you put traditionally dry chemical experiments on TV and make them bearable as well as informative? Here's how!

I came across a sample of 3-M Scotchlite, a high gain relfective sheeting and learned that it can be an effective front projection screen. Normally the ambient light in a TV studio will spill onto a screen and wash out the image. With Scotchlite, the projector and camera are on the same axis or as close to the same axis as possible.

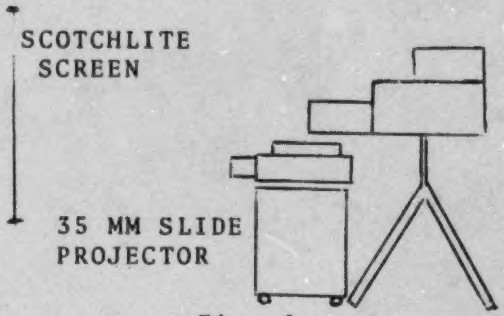


Fig. 1

The intensity of the light will be determined by how close the TV camera lens is to the 35mm projector lens. The farther back the projector and camera from the screen, the smaller will be the angle that they are apart. By adjusting the height of the camera you can control the intensity of the image on the camera. This system allows the camera over the slide projector to be panned to a live studio shot while there are no visuals on the projector. At this point you may say that this is nothing new. They have been using graphics in TV studios like this for years. Now, here is where the economy comes in.

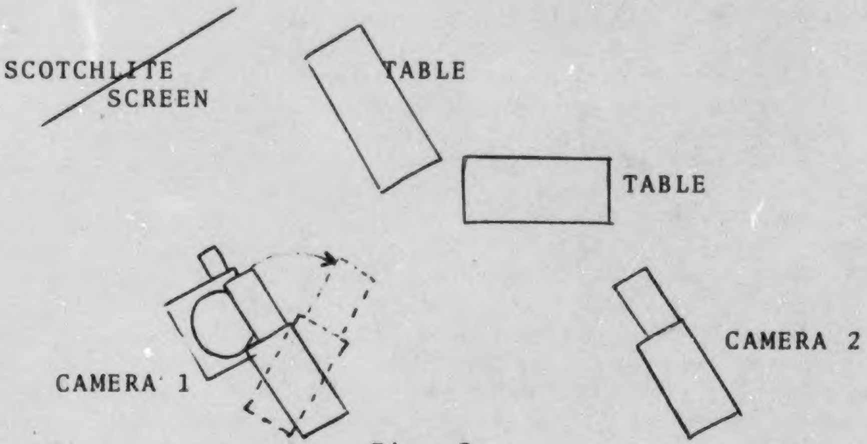


Fig. 2

Usually hard graphic copy requires an extra person in the studio, a luxury that I don't have or need.

All of our graphics are made on slides and masked with a colored transparent tape to add variety to the slides. We go over the script or outline with the college teacher and pick out appropriate pictures, graphics, or words to reinforce important points or major steps in a chemical experiment. The graphics are laid out as they will appear on the TV screen on the story board as in Figure 3.

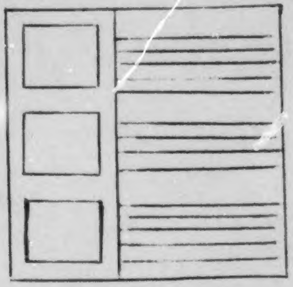


Fig. 3

Our graphics department requires five working days to give us the finished product. This is enough time for the TV crew to obtain the needed props, light the studio, set microphones, adjust cameras, and rehearse without the graphics as well as do their other jobs in the college.

Since the teachers have never been on TV before there is a tendency for them to come across as being very stiff and boring. But the format takes care of that. The person asking the questions or "playing dumb" is the key to the flow of the show. We want the production to look informal but with a very definite structure. The questioner, or second person as I will call him, is wired to the director through a special amplifier and small earphone that is not visible to the camera. Through that earphone the second person is given information to ask the teacher or cues as to which slide is up next so as to lead the instructor in that area. The instructor is then allowed to use normal conversation rather than trying to read a script or memorize notes. The production comes across as a visually enhanced "show me" kind of production.

The director in this format is the hub of activity. He advances the slides on the 35mm projector, mixes the audio, reads the cues to the second person (questioner), advises the second person to have the instructor do something or hold something for a better view. Additionally the director must mat the slides that are in the studio over the other camera. Matted slides of various colors are most effective over live shots. Very important words can be flashed on the screen by the director, also.

For the first three chemical modules, I played the second person. Here are some tips for those of you who would like to try this technique:

1. Act as if the cameras are not on so you can cause the instructor to relax.
2. Use conversational English.
3. Use humor and be human.
4. Be aware of camera angles and movement.
5. Hold objects for close view in the same spot.
6. Don't upstage the instructor.
7. Experiment with your own ideas.

The same format can be useful for a talk show. Set your studio up as shown in Figure 4 and bring in pictures, slides, words, or graphics to clarify points. A random access projector works well with all the slides trayed so that the director can dial up the appropriate slide at any time and cue the questioner that a particular slide is ready.

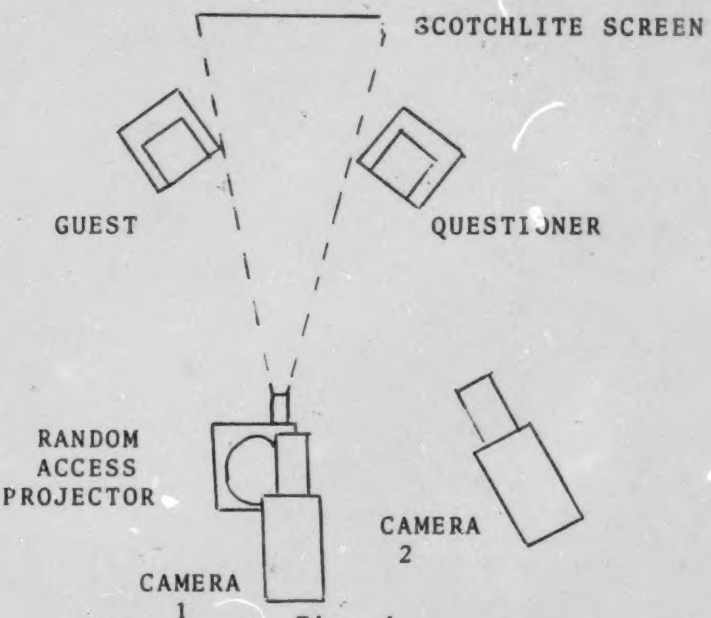


Fig. 4

If you must go with a one person talking face then enhance the production by placing the person in front of a large Scotchlite screen about 6' x 8'. Two slide projectors working with a dissolve unit make a talking face come alive with an appropriate background. Unlike a film chain, the slides or visuals can be panned and zoomed to create an illusion of movement even with a static slide. With a Scotchlite screen and a little imagination you can pull off some polished productions at a small cost with few people.

The following is an example of printed material to accompany the T.V. modules.

Video-tape presentation #1
Pre-Laboratory Exercise on Recrystallization of Aspirin

Worksheet

This sheet is to be completed and handed in prior to doing the laboratory on Recrystallization and Purification of Aspirin.

I. Three components of a complete organic procedure
   1. Synthesis
   2. Purification
   3. Identification

II. Steps taken in this exercise all refer to component #2 - purification.

   1. The solvent used in this experiment is ______________

   2. Water cannot be used primarily because of the effect it has on aspirin. What is this effect?
   ____

   3. Why is the solution heated on steam instead of a flame? ______________________
   ____

NOTE: If the cloudiness produced by the addition of anti-solvent heptane is difficult to see because the solution is very dirty, the solution may be filtered first to remove the solids that do not dissolve. Be sure to use excess chloroform if you do this, or try to redissolve any residue left after filtering in fresh hot chloroform and refilter. Excess chloroform may be evaporated until crystals form and just enough readded to dissolve before adding the heptane. Sometimes quite a bit of heptane is needed to produce cloudiness. The solution should be hot and clear before adding Norit decolorizing carbon.

These questions should be answered with 80% or better accuracy before doing this experiment in the laboratory.

1. The antisolvent used in this experiment is:

   a. chloroform
   b. hexane
   c. heptane
   d. norite

2. Water is not used as a solvent primarily because:

   a. It is a good solvent but decomposes aspirin
   b. It is a poor solvent and does not decompose aspirin
   c. It is a poor solvent and also decomposes aspirin
   d. It does not boil quickly enough

3. The Norite is used in this experiment for the purpose of:

   a. Removing solid impurities
   b. Removing dissolved impurities
   c. Removing product
   d. Improving the taste of the aspirin

4. If the stemless funnel and beaker holding the fluted filter paper are not preheated prior to filtering the result will be:

   a. A greater yield of product
   b. More impurities in the aspirin
   c. A somewhat reduced yield of purified aspirin
   d. Much purer aspirin

5. If the crystals of aspirin are allowed to form rapidly after the first filtration by cooling in ice water the result will be:

   a. A much purer form of aspirin
   b. Impurities trapped in the crystals
   c. A higher yield of crystals
   d. No crystals will form

6. The second filtration of the aspirin crystals requires the use of:

   a. A stemless funnel
   b. A short stem glass funnel
   c. A Hirsch or Buchner funnel with filter pad
   d. none of these

7. Solutions in which the filtrate is to be saved and residue discarded should always be filtered with:

   a. A Hirsch funnel
   b. A Buchner funnel
   c. A stemmed or stemless glass funnel
   d. None of these

8. If the aspirin is not thoroughly dry:

   a. It is considered pure
   b. It will weigh the correct amount to calculate percentage recovery
   c. Its melting point will be correct
   d. Its melting point will be considerably off

9. Crystals of Aspirin which are left in the beaker (where the crystals formed) after pouring into the Hirsch funnel, may be recovered best by:

   a. Washing out with water into the Hirsch funnel
   b. Washing out with fresh chloroform
   c. Washing out with heptane
   d. Washing out with filtrate (mother liquor)

10. The best method (listed) for determining the purity of the purified and recrystallized aspirin is:

    a. Melting point determination
    b. Taste
    c. Texture
    d. Infrared spectrum

ALLIED HEALTH

Chemistry for Inhalation Therapy

Karen Timberlake
Los Angeles Valley College
Van Nuys, California 91401

Presented to a Symposium of Chemistry Related to Careers at the Forty-Third, Two-Year College Chemistry Conference, Penn Valley Community College, Kansas City, Missouri, February 7, 1975.

My adventures into the chemistry of respiratory therapy developed out of the initiation of a respiratory therapy program at Los Angeles Valley College. By the spring of 1973 approximately one-third of the students in my chemistry class were also taking their first courses in RT. Heretofore, my class consisted primarily of students who were working towards acceptance into the two-year RN program at Valley College. As I talked with the RT students and helped them with some of the concepts in their RT classes, I began to find a beautiful application of some of the chemical concepts which we were studying. In fact, the RT students were the ones who realized that it was chemistry which was involved in the RT class. I had also just found out that one semester of the RN class dealt with aspects of respiration and the nursing involved in the care of a patient with ventilatory difficulties. As I added some material in respiration,I discovered many students who had first hand experience with respiratory problems such as asthma, emphysema, or accidents or drugs which affected their ventilation; others had members in their family with emphysema.

Many students were quick to relate to the applications of chemistry to concepts in ventilation and respiration. In addition, I was really glad to find an interesting application for some of the areas which were previously a bit boring chemically (both to me and to the students).

I'd like to say a few words here also about the teacher who ventures into an area which is not a specialty. This, to me, has been a most delightful and refreshing experience. The greatest thing we all have going for us is our background in chemistry. It is my personal feeling, certainly prejudiced, that the courses with which many of our students continue, zoology, physiology, microbiology, etc., are based on chemical concepts. Certainly, I was concerned about venturing into an area such as respiration therapy, but I developed a few guidelines and a positive approach; (1) The applications related to RT were to serve as a bridge to respiration therapy, and were not to be a detailed explanation of respiration theory and treatment. The emphasis was still to be chemistry, with an extension of that information into respiratory therapy. I wanted to form a bridge between the chemical concepts we were learning and an area of student interest. This had two effects: First, an increase in student participation in learning chemistry; almost a validation of the need to study chemistry as a prerequisite to their subject of interest. Second, there was the later effect of students remembering their chemistry because of related information given to them in the RT classes. Because of the tie-in we had made in chemistry, they were reminded of the chemical principles later on.

(2) I decided that I did not need to dwell upon detailed physiology or techniques of the related field. I found that only the basic location and characteristics of certain physiological features were sufficient.

To treat any information dealing with the biological system, it is impossible to separate the chemistry totally from the biology and physiology. The point I am making is that I keep the emphasis on the chemistry after a brief description of biological and physiological parameters.

(3) I did not have to know or even understand all about RT concepts. My first effort was to relate Boyle's Law and ventilation between the atmospheric gases and the lungs. This effort was so rewarding in terms of increased interest, improvement in understanding and improvement in test scores that I continued to learn what I could and to relate what I had learned.

To give you some insight into the relationship of chemical concepts to respiration therapy I will proceed with some transparencies and related discussion:

Nomogram - nomenclature of chemistry, concentration of solutions, pH and partial pressures

Brief Physiology -- lungs in thoracic cavity (ribs and pleura) diagram; air passageways narrow down -- trachea divides into bronchus, a pari, subdivides and divides again ending in small sacs called alveoli. It is here in each alveolus, that gas exchange occurs. Each alveolus is surrounded by venous and arterial capillary system. The student may label the picture if it is provided as a handout on a ditto. (Some transparencies are available from Ward Natural Science Establishment, Rochester, N.Y. or Monterey, CA.

Boyle's Law -- Ventilation. Movement of gases in and out of the lungs. Inspiration occurs when muscle diaphragm flattens out increasing the volume of the thoracic cavity and allowing atmospheric air at a higher pressure to flow into the lungs, expanding them until the pressures equalize. Expiration is a passive activity whereby the diaphragm relaxes and moves up into the thoracic cavity decreasing the volume. The lungs decrease in volume, and gases inside the lungs are now at higher pressure than atmospheric gases and the gases flow out of the lungs into the atmosphere.

Dalton's Law -- It is interesting to compare partial pressures of gases in the air and the lungs; inspired air versus expired air and alveolar air.

Henry's Law -- Relates to solubility of gases in a solution. Respiratory therapists use a term, gas tension, for blood gases. It concerns the amount of gas dissolved to form a saturated solution of that gas.

One may compare the partial pressure of oxygen and carbon dioxide in air and lungs and then in the body fluids with the partial pressure of gases in arterial and venous blood as well as with the values assumed for the tissues. The processes of passive diffusion can be used very well to illustrate gas exchange. Notice that the gas tension in the arterial blood is the same as the partial pressure in the alveoli. This is expected if good membrane diffusion is occuring and equilibration is taking place. The oxygen diffuses again from the higher tension in the arterial blood to the tissue with a lower oxygen tension. Oxygen is a prime requirement for cellular respiration involving processes such as the Krebs cycle. The end products including carbon dioxide are in higher gas tension than in the blood, thus carbon dioxide diffuses in the blood and the blood is now venous blood. Venous blood is carried to the capillaries surrounding the alveoli and carbon dioxide diffuses across the barrier. The carbon dioxide diffuses much more easily than oxygen and does not need a great concentration difference. The carbon dioxide tension in arterial blood is in equilibrium with the partial pressure of the carbon dioxide in the alveoli.

LeChatelier's Principle -- May be carried into a model hemoblogin association and dissociation with oxygen and carbon dioxide. The high concentration of oxygen in the lungs would favor the association while the low concentration of oxygen at the tissues would favor the dissociation. The carbon dioxide in the cells will combine with water, forming carbonic acid or carbonate and hydronium ion. The increased acidity associated with rapid utilization of oxygen will favor the increased dissociation of oxygen in that tissue. The same sort of reasoning will apply to the association of carbon dioxide and its release at the lungs.

When dealing with a respiratory patient, the therapist will deal with four parameters. For normal blood gases these would be: arterial CO_2, 40 torr; Carbonic acid, 1.2 meq/l; bicarbonate, 25 meq/l; and the pH, 7.4.

Concepts of acid-base equilibria, buffers and equilibrium constants for a weak acid can be extended to include the Henderson-Hasselbalch Equation for the bicarbonate-carbonic acid system in the blood.

$$\mathrm{pH} = 6.1 + \log \frac{HCO_3^-}{H_2CO_3}$$

$$\mathrm{pH} = 6.1 + \log 20$$

$$\mathrm{pH} = 7.4$$

As long as the bicarbonate/carbonic acid is 20.1, the blood pH will remain at 7.4.

Problems with a respiration patient occur when there is difficulty with accumulating or expelling too much carbon dioxide. This is a respiratory condition which can lead to metabolic problems. Other metabolic problems such as too much or too little acid or bicarbonate concentration, result in too high or too low a pH which also affects respiratory levels. Respiratory acidosis is too much carbon dioxide in the blood. It is one of the major problems with which the therapist deals. There is difficulty with alveoli diffusion. From the equilibrium viewpoint, there is an increase in hydrogen ion concentration which causes a lowering ofpH. A blood pH below 7.2 becomes very serious. Respiratory alkalosis is too little carbon dioxide in the blood caused by hyperventilation which is othen emotional. The effect is to lower the hydrogen ion concentration which thus increases the pH. A pH above 7.6 becomes very serious. Changes in pH due to anything other than carbon dioxide and respiration are called metabolic.

Increases in hydrogen ion or decreases in bicarbonate ion lead to acidosis. Considering the equilibrium again, there is an effort through respiration changes to lower the carbon dioxide to rid the blood of the increase in pH. This will also lower the bicarbonate ion concentration since it combines with the hydrogen ions. When there is too little hydrogen ion, pH increases. The body may try, through compensating in ventilation, to retain some more carbon dioxide to reverse the direction of reaction and return to the normal pH.

As I said earlier, one big problem that the therapist encounters is in ventilatory failure. This occurs when the partial pressure of the carbon dioxide goes above 55 torr (compared to the normal 40 torr) or the partial pressure of the oxygen gas goes below 60 torr (compared to the normal 100 torr). Causes include hypoventilation caused by damage to the respiratory center, drugs, emphysema, chronic bronchitis or fibrosis impeding diffusion of gases and thereby causing accumulation of carbon dioxide in the blood.

Ventilators operate according to Boyle's Law. They operate by changing conditions of pressure or volume and move gases in and out of the lungs. The iron lung, now in little use, enveloped the body. A piston changed the volume of the iron lung. The thoracic cavity and the lungs responded to this change and the patient brought atmospheric air in and out of the lungs. It was called a negative pressure machine as it created negative (lower than ambient) pressure so diffusion in one direction occurred.

Today, ventilators are positive pressure. The lungs do not move so much and thus the patients energy is saved. Positive pressure ventilators create higher than atmospheric pressure which causes a gas to flow into the patient's lungs. Air-gas mixutres are delivered through the nose or mouth and sometimes directly through the trachea. Such delivery requires a high moisture content to prevent a drying of the alveoli membranes which would hamper gas diffusion through the membranes.

The preceding examples hopefully have given you some insight into the many chemical concepts which can be applied in a course relating to respiration therapy.

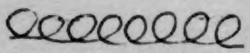
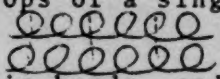
Chemical Effects on Tensile Strength of Hair

Wanda Sterner
Cerritos College
Norwalk, Cal. 90650

Presented to a Concurrent Session of the Forty-Second Two-Year College Chemistry Conference, Houston, Texas, December 7, 1974.

THEORY:

Keratin, the major component of hair, seems to consist

of long protein chains in helical form, six twisted around a seventh one. (See Pauling's College Chemistry, Freeman, 3rd ed., 1964, pp 733-6). The backbone of the protein chain is formed by peptide bonds between COOH and $C-NH_2$ groups on adjacent amino acids. The main thread of the helix is the peptide backbone. The other functional groups on the amino acids stick out at the sides of the backbone and form cross links from one protein strand to another, both between loops of a single helix  and between helices: 
The cross links are hydrogen bonds, ionic bonds, and disulfide bonds. The disulfide bonds form between cysteine fragments in both protein strands. Hair is about 18% cysteine; silk and gelatin have almost none. (See Appendix B in Science in Cosmetology for amino acid content of common proteins.) So hair has lots of disulfide cross links.

Most damage to hair, breakage, is caused by mechanical things like combing and brushing. The more tensile strength hair has, the more resistant it is to mechanical damage. Some beauty salons use a %150 device to determine the tensile strength of a customer's hair.

Conditioners should add to the tensile strength. They coat the hair and increase strength that way. You could test their effects with this method, I haven't done that yet.

This experiment can be used to determine different things: tensile strength, elasticity, and effects of different solutions. Water breaks hydrogen bonds and ionic (salt) bonds that form cross links. Setting lotions (slightly alkaline) will break more bonds than water. Permanent waving lotions break the disulfide bonds. Such lotions are reducing agents, usually thioglycolic acid or salts of it. (Permanent waving "neutralizers" are mild oxidizing agents which mend the disulfides that are near each other after the hair has been curled into a new shape.) Thioglycolic solutions are used for straightening excessively too curly hair in the same way. More drastic straightening is done with sodium hydroxide solution. If it is too strong or is left on the hair too long, the hair becomes mushy as the peptides themselves are hydrolyzed. Metallic dyes, such as New Dawn, react with the disulfides and leave the hair vulnerable to destruction. If a permanent waving lotion is unknowingly applied to hair after such a day, apparently all the disulfide bonds are broken.

EXPERIMENTAL:

A. Tensile Strength

Materials: hairs (three inches or longer), a ruler, masking tape, cotton, lotions, weights with hooks on them.

Procedure:

1. Mount the ruler in a clamp to hold it upright. (It can be placed in a graduated cylinder.)

2. Attach the hair as in Figure 1.

3. Add weights gradually until the hair breaks. The total weight is the tensile strength.

B. Elasticity

Procedure:

1. Mount hair as in the illustration, Fig. 1

2. Record the length at bottom of loop of hair
   a. ____________

3. Add weights until hair stretches but not until it breaks. (This will take several tries.)

4. Record stretched hair length at bottom of loop
   b. _______________

5. $\frac{b - a}{a} \times 100 = \%$ elasticity.

6. 30 - 40% is good.

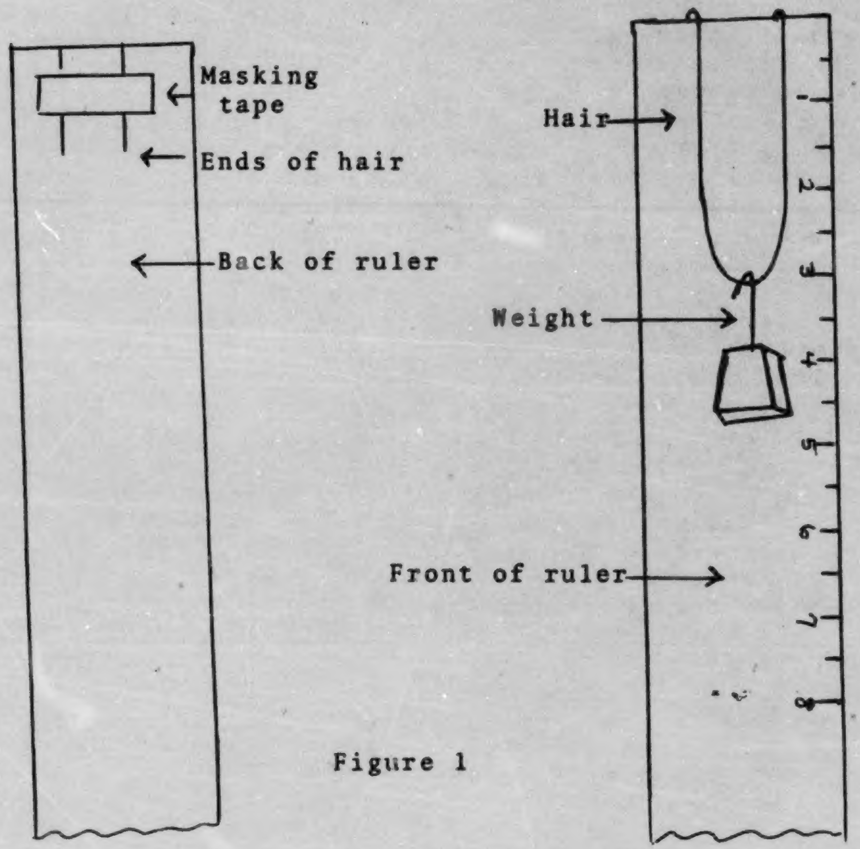

Masking tape
Ends of hair
Back of ruler
Hair
Weight
Front of ruler
1
2
3
4
5
6
7
8

Figure 1

C. Effects of Water

Procedure:

1. To hair stretched as in B3 add water by means of a cotton wad dipped in water. (If this is the only thing you are oing, the ruler in a graduated cylinder can have water poured over it for more dramatic effect.)
2. If possible record new length and calculate % elasticity when wet.
3. As a check to be sure elasticity was not exceeded, weight can be removed and hair (still on ruler) can be dried at 100°C in an oven for a few minutes. If it goes back to the original length you did not exceed the elasticity and the results will be valid.

D. Effects of other Solutions

Procedure:

1. To stretched hair, add solution to be tested by a cotton swab. Setting lotion has a smaller effect, permanent wave lotion has a greater effect than water alone.

Allied Health Chemistry Labs

Mamie Moy
University of Texas
Main Campus
Houston, Texas 77004

Presented to the General Session of the Forty Second Two-Year College Chemistry Conference, Houston, Texas, December 7, 1974.

In recent years much interest and emphasis have been placed on the amounts of broad chemical knowledge for students majoring in the health sciences, home economics, agriculture, veterinary medicine, etc. Large numbers of textbooks have been written and published covering very generally and very specifically the topics in chemistry which will again be applied in the professional courses. Along with the textbooks there have also been a large number of laboratory manuals published for these students.

As one looks over the table of contents of the laboratory texts, one finds the same list of experiments: use of the bunsen burner, measurement of mass, volume and length, sepataion of solids, gas laws, preparation of hydrogen and oxygen, classes of organic compounds, preparation of aspirin, qualitative tests for carbohydrates, fats and proteins, blood analysis, etc. Regardless of the major field of interest of the students, we recognize the need for all of these students to learn laboratory technique in some form or fashion very early in the laboratory course. The students will need to use these tools and skills in performing experiments later in the semester.

A quick review of the experiments listed in these laboratory manuals generally shows that very few, if any, of these experiments make use of the quantitative techniques which are used in the laboratories found in the hospitals, clinics, control laboratories and other industrial areas. I think that it is important for these students to be exposed to some of the techniques as well as learn fundamentals and principles. All of this knowledge should be taught in such a way that there is meaning and applicable to the fields of study of the students.

Chromatography, especially paper chromatography, has been used extensively in many of the qualitative analysis and tests of the biologically important substances. Chromatography can be extended to include gas chromatography and thin layer chromatography to show the same principle of separation. There are simple experiments which can include not only the qualitative analysis of mixtures, but also a quantitative determination of the components by using a gas chromatograph. Not all student laboratories can afford a large number of these instruments since basic standard models cost about $750.00. However, with a little time and work one can build it for about $75.00 and a recorder purchased to go with it for about $150.00.

Another area which is important to the students in the health sciences and related fields is the measurement of pH, buffering action and electrolytes. These equilibria can be demonstrated in the titration of strong acids, strong bases and weak acids and bases. The results obtained by use of phydron paper are as acceptable as the results obtained by use of the low cost student model pH meters in the titrations. Instead of using solutions of acid or base made up in the laboratory as unknowns there is more interest shown by the students if commercially available antacid compounds are used as unknowns. Rather than work for an answer known by the instructor, the students are working for an answer which the instructor must accept as either being right or wrong. This seems to challenge the students and, consequently, the students do better work.

Color reactions for the presence of carbohydrates and proteins can be observed qualitatively and quantitatively. An inexpensive colorimeter can be used to give fair results. Commercially available colorimeters can be purchased for as low as $40.00 each. Again these instruments can be built for a fraction of this amount - about $10.00.

Some experiments which can be included in a laboratory course for the students in the health sciences and allied fields are:

1. Extraction of butterfat from milk
2. Extraction of proteins from milk
3. Semiquantitative determination of alkalinity of a commercial antacid compound
4. Chromatographic methods for separation of components in natural products
5. Preparation of a polyamide
6. Isolation of a natural product
7. Colorimetric determination of carbohydrates and proteins

The Role of Nutrition in Heart Disease

Jon A. Story
The Wistar Institute of Anatomy and Biology
36th Street at Spruce
Philadelphia, Pennsylvania 19104

Presented to a General Session of the Forty-Fourth Two-Year College Chemistry Conference, Manor Junior College, Philadelphia, Penn., April 4, 1975.

Artherosclerosis is a complex disease of the circulatory system which is influenced by many factors. Most of these factors have been described statistically through studies of large populations and, simultaneously, the leading causes of death in these populations. Experimental work with humans and laboratory animals can then be directed toward elucidating the factors which are actually of a causitive nature.

In studying the role of nutrition in atherosclerosis, many substances in our diets have been indicated as probable causitive agents in the processes leading to atherosclerosis. Saturated fats have long been associated with increased serum cholesterol and atherosclerosis, when compared to unsaturated fats, in experimental animals[1,2] Certain carbohydrates[3] and the source of protein[4] have also been implicated.

A great deal of interest in the role of non-nutritive components of the diet has recently been generated by a series of epidemiological reports comparing the fiber intake of populations with disease frequencies within that population. Burkitt[5] and Trowell[6-8] have reported a strong correlation between high fiber intake and lowered incidence of heart disease, diverticular disease, some types of cancer and diabetes mellitus.

Experimental data concerning the relation between type and amount of dietary fiber and the incidence and severity of atherosclerosis are quite scarce at this time. Kritchevsky[9] summarized available data concerning saturated fats which was dependent on the other components of the diet. He recognized several variables, including type and amount of fiber, which could be responsible for these disparities.

In subsequent experiments, Kritchevsky and Tepper[10-11] examined the apparent "protective" effects of chow in feeding of saturated fats. The fat from commercial chow was extracted and added to a semi-purified diet and coconut oil was added to the chow residue. Coconut oil was not atherogenic when added to the chow residue but was atherogenic in the semi-purified diet even when the extracted fat (iodine value, 115-120) was added. Thus the chow residue contained the "protective" agent.

Moore[12] reported lower severity of atherosclerosis and lower plasma cholesterol when rabbits were fed diets containing natural types of fiber (wheat straw or peat) as opposed to diets containing cellophane or cellulose. Cookson *et.al.*[13] and Cookson and Fedoroff[14] have shown that alfalfa protected rabbits from the hypercholesteremia and atherosclerosis normally resulting from cholesterol feeding.

The mechanism of fiber's hypercholesteremic effects has not been fully delineated. Work done in this laboratory[15,16] indicates an inhibition of cholesterol absorption in alfalfa-fed animals. Rats were fed isocaloric, isogravic diets containing either alfalfa or cellulose as a source of fiber. The animals were given an oral dose of ^{14}C-cholesterol 48 hours before being killed and the recovery of radioactive steroids in the feces was taken as a measure of cholesterol absorption. In every case rats fed diets containing alfalfa absorbed less cholesterol than those containing cellulose as a fiber source.

We then investigated the possibility that fiber had interfered with cholesterol absorption by binding bile salts and found[17,18] that many types of fiber sources bound appreciable quantities of sodium tauro- and glycocholate *in vitro*.

The mechanism responsible for the hypocholesteremic effects of fiber appear to be related to its ability to bind bile salts and thus inhibit cholesterol absorption. Since bile salts are synthesized from cholesterol and they would not be reabsorbed after being bound to fiber, an additional loss of the cholesterol being used to synthesize bile salts would result. It has also been suggested that the increased fecal bulk and decreased intestinal transit time, effects often associated with high fiber diets, would alter both cholesterol and bile acid absorption.

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14. Cookson, F.B., and Fedoroff, S., Brit. J. Exp. Pathol. 49:348 (1968).

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18. Story, J.A., and Kritchevsky, D., Nutr. Rep. Int. 11:161 (1975).

Chemists Relating to Allied Health Personnel

Sister Mary Maurice Boyle
Mercy Catholic Medical Center
Darby, Pennsylvania

Presented to a General Session of the Forty-Fourth Two Year College Chemistry Conference, Manor Junior College, Philadelphia, Penn., April 4, 1975.

To discuss the topic, "Chemists relating to Allied Health Personnel", in twenty minutes forces one to make a choice. Possibly in this amount of time, one could at least enumerate the multitudinous ways in which this relationship exists. However, an alternate possibility is to choose a few priorities and elaborate on them. This latter choice would seem a more fruitful one for a meeting such as this and for this reason, I have chosen to focus in on three major issues which derive from this relationship. These issues emerge in the form of three very natural questions: Just what is the relationship between chemists and allied health personnel? -- Why does this relationship exist? -- and finally, How does one go about preserving and enhancing it?

The answer to this first question is bound to be somewhat biased. For a number of years I have taught chemistry to allied health personnel and currently, in addition to teaching, I am coordinating several allied health programs, many of which require some form of chemistry. Both chemists and allied health personnel have much in common. Both groups are professionals in their own right. The chemist deals, not just with matter, but with the matter which forms the very essence of life. Truly chemistry is basic to biology, the science of life, and a group such as you do not have to be reminded that the interface between biology and chemistry in the form of bio-chemistry has made unprecedented advances in our understanding of the material basis of life during the past couple decades. Allied health professionals have chosen careers which involve them in some specific way with better health care delivery and consequently with the preservation of life itself. The chemist deals with the theory of life processes and the allied health professional helps to put that theory into practice. The more one understand what he or she is doing, the better he or she is able to do it. This is true whether it be a nuclear medicine technologist scanning an organ which has picked up an injected radioisotope or a medical technologist electrophoresing serum proteins or lipids or any allied health professional performing a chemistry related task in his respective field. Suffice it to say that there is a resonance in the structure which binds the chemist to the allied health professional, whether that chemist be his teacher or his co-worker.

Why does the relationship between the chemist and the allied health professional exist? Actually why does any relationship exist? An appropriate analogy here might be to consider the allied health professional in equilibrium with the chemist and since all of us are proponents of LeChatelier's principle, we can expect this equilibrium to be maintained, with or without stress. The allied health professional needs the chemist and the chemist has much to gain from these very needs. Many of the allied health programs which require chemistry are either two-year certificate programs or associate degree programs. For the purposes of this paper, I would like to confine my remarks to these programs - or rather to those professionals which emergy from these programs. In this situation, a student preparing to enter an allied health profession must acquire a great deal of knowledge in a short time. No matter how highly motivated, intelligent, or scholarly that student is, there is a limit to what he should be expected to learn well in a limited time. In these two year programs, approximately one year is spent in didactic components and the other year in clinical practicum. This is generally the time allotment, whether the program structure is an integrated one or whether the clinical year follows the academic year. The didactic component consists of basic science courses, mathematics, and a core of liberal education. Since we are limiting ourselves here to the needs in chemistry, there are a few thoughts on this which I would like to share with you. If a college is involved in preparing students for the allied health fields my hope would be that it would be flexible enough to structure chemistry courses in such a way that all allied health students get the basic principles of chemistry but following this there is leeway for options in more specialized topics peculiar to the various allied health fields. Depending on which field is being considered, certain topics in general chemistry, organic chemistry, analytical chemistry, and biochemistry are needed. The traditional first year general chemistry course is not the answer to these needs. It is possible that a good integrated course could supply a better approach but what presently seems to be the ideal situation is a well-planned modular system and I am certainly happy to see this as part of tomorrow's program. In essence, what I am proposing is that the allied health student who is enriched in his profession by theoretical knowledge in certain areas of chemistry should be able to get that background from a course of study geared to meet the objectives of the allied health program in which he is enrolled. There really is no harm being done to the "purity" of traditional chemistry courses in such an approach. Actually, a truly great chemist and teacher can be flexible and innovative enough to adjust his course to serve the best interests of the students he teaches especially when he realizes that by this he is ultimately serving the best interests of society which will be the consumer of the health care delivered by these allied health professionals.

Another point which is apropos for this audience is the fact that two-year colleges by their very philosophy are better able to make such curricular adjustments than four year colleges. Since terminal education is basically the concern of these institutions, they do not tend to sacrifice the objectives of programs by assuring students of total transferability of credit. By this remark, I do not intend to imply that two-year colleges militate against upward mobility, but rather to emphasize their role in preparing a student for career entry at the end of two years.

To illustrate a possible approach to modularization, let me share a start which we have made in nuclear medicine technology and medical laboratory technician programs. Following is a list of topics from basic chemistry which are applicable to allied health sciences in general:

Inorganic Chemistry

Units of measure
Structure of matter
Chemical bonding
Gas Laws
Oxidation-Reduction
Water
Salts
Properties of matter

Inorganic Chemistry (con'd.)

Radioactivity
Chemical Equations
Oxygen
Liquid Mixtures
Acids and Bases
Ionization

Bio-organic Chemistry

Structure of organic compounds
Alcohols and esters
Cyclic compounds
Carbohydrate structure
Protein structure
Vitamins
Heredity
Hydrocarbons
Other organic compounds
Heterocyclic compounds
Lipid Structure
Enzymes and Catalysts
Hormones

How then does one go about enhancing and preserving the relationship between chemists and allied health professionals? The answer to this question appears to be very much tied up with attitudes and attributes. The chemistry teacher might well have to rethink his philosophy of what chemistry education is all about. There is a real need for innovative programs in chemistry if allied health professionals are going to come to their professions adequately prepared. This offers a real challenge to chemists and necessitates cooperative effort on the part of chemists and allied health personnel. If both recognize the value of this concerted effort, they will consider time and effort put into such a project, time well spent.

One attitude that should be avoided is that a student entering a vocationally-oriented program, such as one of the allied health areas, is a second class citizen on the educational ladder. Actually, in my experience, I have found students in the allied health professions extremely highly motivated and unusual in ability. In fact, I would prefer to refer to them as scholars in the true sense of the word.

Student attitudes are also important. These allied health students know what they want and above all they would like their preparatory courses to be relevant and meaningful. They need and look for a background in chemistry which is broad in scope, but which stresses applications which will be of importance in their professional work.

The chemistry teacher has an excellent opportunity to help these students to develop attributes that will stand by them as they pursue their careers. The discipline of chemistry lends itself to developing appreciation for precision, accuracy, and above all, honesty.

In conclusion, I would like to address these final words to chemists since you are now my audience. However, if I were addressing a group of allied health professionals, the substance of these remarks would not change. Only the emphasis would be different. You do have a very challenging opportunity before you. The Allied Health Profession needs you. It needs both your dedication and your inspiration. The extent to which this dedication and inspiration influences the students now in your allied health programs will determine the type of allied health professional which we will be able to expect in the future. In the beginning of this paper, I suggested a common relationship between you, the chemists, and the allied health professionals, in that you both deal with the material basis of life. Now I ask, 'Are you willing to keep this relationship alive?' 'Will you be willing to keep chemistry on the move in the allied health professions all the way into the twenty-first century?'

General Chemistry-Allied Health Interface

Onofrio Gaglione
New York City Community College
Brooklyn, New York 11201

Presented to a General Session of the Forty-Fourth Two-Year College Chemistry Conference, Manor Junior College, Philadelphia, Penn., April 5, 1975.

INTRODUCTION

The interface between two immiscible liquids is generally characterized by a unique tension resulting from the intermolecular forces that are specific for both liquids. If General Chemistry is to be the interface that connects and divides the various allied health professions, then it is of significant importance that we characterize General Chemistry in this particular role. As in the case of the liquid-liquid heterogeneous system there is interfacial tension, so too in allied health professions that are connected by a common divider, General Chemistry, forces exists, emanating from specific disciplines, which describe the state of the interface, General Chemistry. It is therefore significant that a General Chemistry Curriculum consider the necessary requirements of each allied health area.

NATURE OF THE PROBLEM

The chemistry departments of most New York City community colleges are responsible for providing students from various Allied Health fields, such as Nursing, Medical Laboratory Technology and Dental Hygiene, with an introductory course in college chemistry which will serve as a foundation course that will enable them to pursue a career in one of these Allied Health area. Some of these graduates will continue their studied in related professional and graduate schools.

With the advent of open enrollment in the City University of New York, many educators and health scientists have begun to re-examine the traditional curricula in order to assess their relevance in the urban college of the 1970's. The principle concern is that this new wave of students coming to college in the next decade should be exposed to a curriculum that comprises necessary subject matter and methodology for producing health scientists that are equipped to function and pursue further study in their chosen field despite differences in high school preparation resulting from social conditions in large cities.

I shall discuss the need for academic reform in the teaching of college chemistry to Allied Health students without ignoring the social aspects that have already affected the students who will be entering open enrollment colleges in the 1970's. In addition to this the effectiveness of the new elementary school and high school science curricula will be examined in order to understand some of the problems that arise from massive curriculum reforms that are geared to teaching science to a student body whose academic and social backgrounds span a much wider spectrum.

EDUCATION AND SOCIAL PROGRESS

"Education is the fundamental method of social progress and reform". These are the words from one of John Dewey's early works in which he made a significant contribution to the wedding of education to social progress. Some fifty years later after having studied this marriage and the effects produced from it, James Conant (1961) focused on the educational chaos that results from the inequality inherent in the schools of the poor, primarily in large urban areas, compared to the schools in the in the more affluent surburban communities. Why is it then, that Dewey and the educators that followed him for sixty years were not able to develop an educational system that is positively linked to social progress and reform? Conant (1961) believes that the attainment of social efficiency can only occur through greater specificity in the schools. He suggests that schools should be concerned with curricula that fit the subsequent employment of the students in the general locality of the school without replacing the essential parts of the academic programs.

Since many of the students who are entering open enrollment colleges today were educated in the 60's in school systems and communities that were so chaotic that they attained a state of "social dynamite" rather than one of social efficiency, is it any wonder that two year colleges are concerned with the relevancy of their curricula in enabling students to achieve a meaningful place in the educational and social community. On the other hand the college has an obligation to the academic community and society in general to produce competent individuals. It cannot create a new kind of "social dynamite" by promoting all students regardless of ability.

Therefore, the solution of this problem lies in curricula that are relevant both to the students' academic backgrounds and the necessary skills needed in a particular profession. If a chemistry curriculum designed for allied health students in a New York City Community College is to be revised, the authors should be concerned not only with the current elementary and high school science curricula but also the subject matter and skills that must be learned by these students in a chemistry course so that they will be able to function as competent health scientists in a society that will attain a greater degree of efficiency.

REVISIONS OF COLLEGE CHEMISTRY CURRICULA

The past decade has produced a number of advances in teaching techniques and methods of assessment in introductory college chemistry courses. Consider the following annotated bibliography:

1. Experimental Curricula in Chemistry, Hume, D., Advisoty Council on College Chemistry, October 1963, 59pp, ED 013078
   Four programs are identified and described as representative of the experimentation being conducted in the undergraduate chemistry curriculum in American Higher Education.
2. Instruction in General Chemistry and the Expanding Student Population, Brasted, R., Advisoty Council on College Chemistry, October 1963, 14 pp., ED 013077
   The paper discusses ways to modify and organize a multisection General Chemistry course so that increased college enrollments will be able to take the course maintaining quality of instruction. Visual Aids are suggested.
3. Student Success in Beginning Chemistry at El Camino College, Mooney, W., El Camino College, August 1965, 16 pp. ED 013603
   The purpose of the study was to determine the relationship between students achievement in beginning chemistry and their backgrounds prior to enrollment in the course.
4. A Project to Improve Learning in Chemistry at El Camino College by Introducing Chem Study Films in the 8 mm Cartridge Form for Out of Class Use by Students, Kallen, L., Mooney, W., El Camino College, September 1965, 28 p., ED 015719
   The use of six 16 mm films in chemistry classes was supplemented by the purchase of their 8mm cartridge versions and projection equipment to enable students view the films as an independent study procedure. Study Guides, Quizzes and Evaluations were prepared for use by individual students.

5. A Comparison of the Extent to Which the Same Items are Taught in High School College Preparatory Chemistry and in College Freshman Chemistry, Boston U., Mass. School of Education, 1966, 363 p., ED 025403
The first part of the study sought to determine topics that were common to both. The second part sought to determine teacher and instructor attitudes toward inclusion of topics in high school curriculum and elimination of topics from college. Recommends 135 topics for high school and eliminates 98 topics from college course.

6. Modern Teaching Aids in College Chemistry - Portable Video Recording Systems, New Uses for Films, Computer Assisted Instruction, Lippincott, W., Brasted, R., Advisory Council on College Chemistry, December, 1966, 54 p. ED 014421
Paper summarizes the present and potential instructional applications for each type of media presented.

7. New Trends in Chemistry Teaching, Vol. I (1964-65), Cartmell, E., UNESCO, 1967, ED 011855
Chemistry papers published in 1964 in leading science teaching journals of the world are included in this publication. New developments in college chemistry teaching includes modes and experiments, programmed learning and curriculum reform.

8. Two Year College Chemistry Conference Proceedings, Chapman, K., American Chemical Society, Division of Chem. Educ., 1968, 94 p. ED 030432
The report includes (1) new and developing programs in two year college chemistry (2) beginning chemistry offerings - repair of poor backgrounds in chemistry and math (3) nonscience major chem programs for nonscience student (4) programmed auto tutorial approach to chemistry (5) multi-media approach to teaching chemistry (6) do-it-yourself 8 mm films and film loops (7) CAI in college chemistry.

9. Instructional Objectives for a Junior College Course in Chemistry (1st semester), Capper, M., California Univ., L.A., November 1969, 51 p., ED 033688

10. A Report on the Education and Training of Chemistry Teachers for Two Year Colleges, Mooney, W., Brasted, R., July 1969, 43 p. ED 034532
The report focuses on the needs of two year college chemistry faculties and devises programs to satisfy the needs.

11. An Exemplary Program in Higher Education for Chemists, Engineers and Chemistry Teachers, Ayers, J., Paper presented before the Southeastern Regional MTG. of ACS., November 7, 1969, 28 p., ED 034739

The paper presents a model program for the preparation of chemists, chemical engineers, and high school chemistry teachers. The model is an application of systems technology to program development in higher education. It is based on the structure provided by the Georgia Education Model Specifications for Elementary Teachers.

12. Audio-Tutorial and CAI Aids for Problem Solving in Introductory Chemistry, Lower, Stephen, J. Chem. Ed., V 47, N 2, pp 143-146, February 1970, EJ 020309

Starting from a successful audio-tutorial program, the author initiated a computer assisted tutorial program in solving chemistry problems.

13. A Ten Year Experiment with Chemistry Students, Meszaros, L., J. Chem. Ed., V 45 n 11, pp 767-768 November 1970, EJ 028528

Introduces an evaluation procedure based on student's intelligence and ability to work with others.

14. Chemical Operator (Chem.)III 559.78s - Technical Report on Development of USTES Aptitude Test Battery, Manpower Administration (DOL), Washington, D.C., U.S. Training and Employment Service, June 1970, 16 p. ED 069775.

The United States Training and Employment Service General Aptitude Test Battery, (GATB), first published in 1947, has been included in a continuing program of research to validate the tests against success in many different occupations. The GATB consists of 12 tests which measure nine aptitudes: General Learning Ability, Verbal Aptitude, Numerical Aptitude, Spatial Aptitude, Form Perception, Clerical Perception, Motor Coordination, Finger Dexterity and Manual Dexterity.

15. An Investigation of the Use of Computer Aided Instruction in Teaching Students to Solve Selected Multistep General Chemistry Problems, Grandey, R., Illinois U., Urbana, November 1970, 165 p. ED 056515

Emphasis was placed on developing computer routines which interpret student answers in their normal chemical form and tell students what if anything is wrong. Effectiveness of these lessons was determined by analyzing the data generated by students using these lessons and comparing exam results for students who had CA lessons with those had had not.

16. Organocards - Chemical Card Game 2, Kristol, D., Perlmutter, H., Education in Chemistry V8 n 4, pp 145-147, July 1971, EF 042744
Describes the use of the game cards designed to help students master a large number of seemingly diverse yet fundamental reactions of classical organic chemistry. Claims that cards have stimulated students to learn organic reactions more willingly and more independently.

17. Chemsyn - Chemical Card Game 1, Eglinton, G., Maxwell, J.R., Education in Chemistry, V8 n4, pp 142-144, 1971. EJ 042743
Describes purpose and use of a card game which presents the essential groundwork of Organic Chemistry in teaching Aid Form for use by individuals or by groups of 1st year university students.

18. CAI in Undergraduate Organic Chemistry: An Evaluation of Selected Programs, Culp, George, Castleberry, Sam, Science Education, V55, n3, pp 423-430, July/September 1971, EJ 042740.
Compared with students receiving tutorial assistance from teaching assistants and with those with no tutorial assistance, students using CAI programs achieved higher scores.

19. Introduction of Digital Computers into the Undergraduate Laboratory, Perone, S., Eagleston, J.F., J. Chem Ed., V 48, n5, pp 317-322, May 1971, EJ 040973
Describes the first steps of a language program to introduce on line computer applications in undergraduate chemistry.

20. Using Video Tapes to Teach Instrumentation in Organic Chemistry, Nienhouse, E., Nash, Garey, J. Chem Ed, V 48 n 2, pp 141-142, February 1971, EJ 032686.

21. Undergraduate Organic Chemistry: Design, Application and Evaluation, Culp, George, Texas University, Austin, August 1971, 11 p., ED 072630.
The computer-assisted instruction (CAI) program in undergraduate organic chemistry at the University of Texas was evaluated by an experimental design in 1969 and found to be successful. This report discusses in detail the formation of the design, its application, and the method of evaluation.

22. Development of an Undergraduate Course in the Use of Digital Computers with Chemistry Instrumentation, Wilkins, Charles L., Nebraska University, Lincoln, Dept. of Chemistry, June 1972, 5 p., ED 071270

Computer Assisted Instruction (CAI) has proven useful in teaching chemistry instrumentation techniques to undergraduate students. The work completed at the time of this interim report has clearly shown that a general purpose laboratory computer system, equipped with suitable devices to allow direct data input from experiments, can be an effective teaching medium.

23. Managing Chemistry Instruction by Objectives - A Case History, Jacobson, Paul, 1972, 19 p., ED 068093.
At Tacoma Community College (Washington), a chemistry course was taught using instructional objectives. This document describes the course in terms of writing the objectives, instructional procedure and student attitudes. Data and results are reported.

24. Instructional Objectives for a Junior College Course in Basic Physical Science, Purdy, Leslie, 1972, 39 p., ED 067074
The instructional objectives selected are offered simply as samples that may be used where they correspond to the skills, abilities and attitudes instructors want their students to acquire.

BEHAVIORIAL OBJECTIVES: THE PSYCHOLOGISTS, EDUCATORS & SCIENTISTS

The City University of New York is currently initiating a program that will require each department in all of its units to reevaluate and revise its curriculum objectives so that they may be described in terms of a behavior that can be seen and measured. In this way student achievement may be evaluated relevant to the behavioral objectives. This evaluation can then produce feedback that will enable educators to change instructional procedures when necessary to produce a better fit between student test scores and behaviorial objectives.

The development of the proper curriculum objectives requires the cooperation of scientists, behaviorial psychologists and educators. Jerome Bruner (1965) in a series of essays on creativity, learning by the discovery method and school curricula, articulated this concept when he wrote: "Let the school be the place where scholars, scientists, men of affairs and artists come together with talented teachers to continually revise and refresh the curriculums". (Bruner 1965 p. 125.)

A committee of this type will be able to provide the transition from high school background to professional and academic goals of a college curriculum. A study of the modern high school science curricula such as BSCS, Chem Study, PSSC, Project Physics (Hurd 1969), will provide insight into the science backgrounds of future entering college freshmen and help the committee write behaviorial objectives that are realistic.

Therefore, I am suggesting that a General Chemistry curriculum be designed to service the Allied Health Professions. The curriculum writers must be a committee consisting of the following:

(a) College Chemistry Teachers
(b) Health Scientists
(c) Educational Psychologists

Their aim should be the:

(a) establishment of general goals for the content and manipulative skills that must be achieved by the students.
(b) development of performance objectives that will describe measurable student behavior that must be achieved; indicating also conditions and degree of accuracy required
(c) writing of test items based on performance objectives
(d) preparation of a text for content and manipulative skills
(e) preparation and inclusion of various teaching aids, i.e., films, video tape, CAI, etc., where appropriate.

In addition to these functions the committee should also try to compensate for students with deficiencies in high school science and math by preparing a set of modular instructional kits. Each module should be consistent with one of the general content goals and consist of several interrelated concepts which are discussed in the following manner:

(a) Key to pronunciation of word or words that describe the concept.
(b) Definition of the concept
(c) Examples of the concept
(d) Diagrams or other aids where applicable

The content of the module may be recorded on cassette tapes so that students may read and listen to the module simultaneously. In this way the correct pronunciations, emphasis and direction will be clear to the student. The modules should be designed as an independent study assignment for students requiring additional exposure to the curriculum.

When the committee arrives at a curriculum that is relevant to both student backgrounds and the behaviorial objectives set up by the committee then the curriculum must be evaluated in order to determine its effectiveness.

The last decade has produced an avalanche of innovations in the methods of instruction in college chemistry courses especially in General and Organic Chemistry. However, too often new techniques are employed in courses without sufficient research into the relative effectiveness of these innovations in colleges or curricula that have unique objectives.

It is also interesting to note that more recently (1972) educators are turing to instructional objectives as guidelines to modification of college chemistry curricula. The two year or community college must carefully employ instructional aids, i.e., films, television, computers, etc., so that they assist in approaching objectives of the curriculum and not send a student so far afield that he no longer understands the relevance of the course to his chosen field.

Therefore, I suggest that research designs for measuring the effectiveness of teaching college chemistry be specifically constructed to deal with not only the course content but also the goals of the curriculum.

Research is also needed in further application of these instructional aids as methods of assessing students performance in these curricula.

CONCLUSION

The general content areas of an intorductory college chemistry are uniformly accepted by most college chemistry departments and need not be discussed here. It is however, the degree of complexity of topics, the emphasis of certain concepts, the goals of the curriculum and the methods for assessing achievement of the goals that are the crucial aspects in the development of a curriculum for Allied Health students.

Curriculum writers must also be cognizant of the fact that open enrollment will bring to chemistry classrooms students of widely different high school backgrounds.

Let us then develop chemistry curricula for Allied Health students in cooperation with appropriate scientists and educators who can help us establish goals and write performance objectives. When we have done this then let us carefully construct research designs that will give us objective evidence of the effectiveness of our curriculum.

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CHEMISTRY AS A CAREER

Chemistry Moving Ahead in the United States Department of Agriculture

Henry A. Walens
Eastern Regional Research Center
U.S. Department of Agriculture
Philadelphia, Pennsylvania 19118

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INTRODUCTION

As we have heard today, chemistry is moving ahead and I am here to tell you how chemistry is moving ahead in the United States Department of Agriculture as a part of the total research effort of the Department; research that has been moving ahead since 1862. In that year, President Lincoln authorized the formation of the Bureau of Agriculture with research as an integral part of the Bureau. The Bureau became the U.S. Department of Agriculture in 1889 and throughout its one hundred and twelve years of existence research has been carried forward by its many different agencies and bureaus. One result of this research is evident when we consider that in 1900, a farm worker produced enough food for himself and 8 others; by 1950 he supplied 12 other persons and in 1960, 28 others. Today, the American farm worker can raise enough food to feed himself and 56 others, the highest ratio in the world.

I will be talking mostly about the research being carried out at the Eastern Regional Research Center of the Agricultural Research Service. The Agricultural Research Service is an agency of the USDA which carries out research on all aspects of agriculture, from the development of new crops of new hybrids of old crops to finding new or better uses for the final products grown by the farmer. This research is carried out by the various divisions of the ARS, divisions located throughout the United States. However before looking ahead, to see where we are going, I think that we should look back and see how far we have come.

HISTORICAL

In the 1930's agricultural research had exerted its influence on farm production, and the country was inundated with surpluses. Wheat was harvested and piled up in the fields; potatoes were dyed purple to prevent sale and burned because there were too many to be sold. In 1939 Congress authorized the establishment of four regional research laboratories in each of four agricultural areas with a major mission of finding new uses for these surplus crops and commidities. To fulfill this mission, four Regional Laboratories were built in 1940 to carry out research on the agricultural commidities including the surplus ones. Each laboratory had as a primary assignment the crops of the area in which it was located. Thus, the Western Laboratory at Albany, California, was assigned cereal grains, alfalfa, wool and other west coast commodities. The Southern Laboratory at New Orleans, Louisiana, conducted research on cotton, naval stores, citrus fruits, peanuts and other Southern crops. The Northern Laboratory at Peoria, Illinois, took on corn, wheat, soy beans, as well as other oilseeds, and other commodities. The Eastern Laboratory, here in Philadelphia, was assigned meat and meat products, dairy products, honey, maple syrup and eastern fruits and vegetables. The Southeastern Center, a newer Laboratory built in 1969, at Athens, Georgia, conducts research on tobacco, pork, poultry, peaches and other commodities. The research carried out by these centers over the years has led to advances such as the dehydrated mashed potato flake, developed at the Eastern Center, WURLANIZED wool, (a shrink resistant washable wool), developed at the Western Center; materials which impart permanent press or fire resistance to cotton from the Southern Center; and the Northern Center's development from corn of chemicals of a thousand and one uses, from finishing paper to tanning leather. I have given you here only one example each from the many new items developed by the Research Centers.

CURRENT ORGANIZATION

The headquarters for the Research Centers was located in Washington, D.C., as were headquarters of the other divisions of ARS. About a year and a half ago, ARS underwent a reorganization which resulted in a regionalization of ARS units, with each Region being capable of responding quickly to problems within its Region, as well as to national problems. And each Region has one of the former Utilization Centers in it with the Southern Region having two. Also, each Region is divided into Areas. In the Northeastern Region there are five Areas. Three of these Areas are single locations; the Agricultural Research Center at Beltsville, the Plum Island Animal Disease Center, and the Eastern Regional Research Center. The other two Areas encompass many locations. The North Atlantic Area with headquarters at Ithaca, New York, includes installations in the northern portion of the Region and the Chesapeake-Potomac Area includes stations in Maryland, Delaware and West Virginia. The other Regions are divided likewise.

The mission of the Centers has also changed. It has changed from the utilization of surplus crops to finding ways to better utilize what we have, to improving commodities that we have by increasing their nutritive properties or by reducing health hazards, and to improving our environment by reducing pollution due to processing these agricultural commodities.

EASTERN REGIONAL RESEARCH CENTER

Now let us turn to the Eastern Regional Research Center, or ERRC as we call ourselves. The Center at Wyndmoor, a suburb just outside of Philadelphia, is composed of several buildings. The U-shaped main building consists of three wings, with the front of the U being the Administration Wing, the left hand side of the U being the Laboratory Wing, and the third side being the Pilot Plant Wing. We also have a Mechanical Services building where our shops are located, a Service building for steam, heat and air-conditioning, a meat processing building, and a hazardous operations building.

The Administration Wing of the main building contains the offices of the Director and the Laboratory Chiefs, the Library the photographic facility, several conference rooms and an auditorium. The Laboratory Wing has 90 rooms, in groups of three, of which 60 are laboratories, on the first, second and third floors with additional laboratories in the basement area. The Pilot Plant Wing consists of two two-story units, one above the other. The lower level is what we call our primary processing area where items such as potatoes or carrots or apples are received, washed, sorted, peeled and prepared for further processing in the upper area. Other non-food processes are conducted here also. The upper area, known as the Food Processing Area, is where the final work on the preparation of food products is carried out. This area is completely tiled to allow sanitization of the area. There are three laboratories in the Hazardous Operations Building. One is set up as a tannery for the production of leather, a second is equipped as a high pressure reactions laboratory and the third is a solvent processing room. The Meat Processing building is a complete facility for working with meat, containing cold rooms for storage of the incoming product, cutting room, and a smokehouse.

Within this complex, research is conducted on meat, animal fats, hides and leather, dairy products, maple syrup, honey and fruits and vegetables of the Eastern Region. This work is carried out by a staff of 285 full time employees plus about 40 other employees. Of these about 150 are professional scientists, with the balance distributed between the clerical, stenographic, blue collar and other support personnel. The scientific staff is divided into Laboratories, each carrying out research in its designated area. Thus, the names Meat Laboratory, Animal Fats Products Laboratory, Hides and Leather Laboratory, Dairy Laboratory and Plant Products Laboratory are self explanatory. The other two groups are the Physical Chemistry Laboratory and the Engineering and Development Laboratory. The former carries out work on separation techniques and analytical procedures, including instrumental procedures and computer technology, which are of value or use to all the scientific personnel. The Engineering and Development Laboratory conducts pilot plant operations for itself and all other groups--operations which include scale up of laboratory findings, new processing procedures, and original work developed within the group.

The Center has an extensive library, with direct access to the National Agricultural Library at Beltsville, Maryland, and access to all local scientific libraries. Our library receives some 425 different journals each month, ranging from the strictly scientific journals, such as the Journal of the American Oil Chemists' Society and the Journal of Organic Chemistry to trade publications.

We are also quite up to date on instrumentation. Our scientists are well equipped with infrared instruments and gas-liquid chromatographs (GLC).

We have three mass spectrometers, the most modern of which is an instrument equipped with a GLC to separate components, a double focusing mass spectrometer, and its own computer. Thus, the mass spectroscopist can inject a sample into the GLC, pick one fraction out and send it through the mass spectrometer, and read the results off the printout, all within a very short period. Another mass spectrometer is being fitted out to perform field ionization mass spectrometry, a new technique in which the molecule is excited in such a manner as to produce a prominent parent peak and few other peaks, enabling one to easily determine the molecular weight of the compound.

We also have two Nuclear Resonance Spectrometers, an older model, a 60 MHz instrument and the newest addition, a 90MHz, Fourier transform instrument. This instrument utilizes a pulse-type scan, with pulse times of one to on hundreth seconds. The pulse scan allows repetitive scanning of the spectrum; the self-contained computer stores, accumulates and computes the information and then prints out the results when wanted.

We have an electron miscroscopy section with transmission and scanning scopes. The scanning scope arrived about one year ago and became a work horse with almost every group in the Center making use of this instrument. The Detergents group has used the scope to determine the amount of cleaning that occurs when using different detergents and the Plant Products Laboratory has looked at fungal action through the scope. In conjunction with the Meat Laboratory, the electron microscope group has been conducting investigations on what makes meat tender. For this purpose, they have designed a miniature motorized mount that can be introduced into the sample chamber of the electron microscope. A piece of meat is clamped into the mount and the motor is energized, pulling the piece of meat apart. To record this dynamic process, we have obtained a complete TV recording outfit, and by taping the output of the SEM, we can have instant replay and stop action of what is happening in the SEM. We then have our computer installation composed of an IBM 1130 unit with various pieces of hardware such as an X-Y plotter, a Modcomp unit for additional processing capacity and an additional disk readout unit. The latter two allow us to interface many of the laboratory instruments with the computer, and some of the first cables are now being run in. This will allow the laboratory scientist to spend less time on calculation of results from his instruments for the computer will do them for him. At present, we are planning to interface 60 instruments with the capability of doubling this number. Except for the individual instruments located in the laboratories, all the aforementioned instruments are part of our Physical Chemistry Laboratory.

Another instrument known as an amino acid sequencer is located in our Dairy Laboratory. This instrument is used by the Dairy group to analyze the primary structure of proteins, breaking down the protein one amino acid at a time. This information will help us to understand better why one protein has certain properties and another does not, or perhaps even enable us to synthesize proteins, tailoring them to our needs.

RESEARCH PROGRAMS

Nutrition conscious consumers and industry are becoming increasingly aware that there is more to protein than just the quantity consumed, and that certain foods provide better nutrition than others. It is not sufficient to know the amount of protein in a food; we must also know the nutritional efficiency of the protein. Thus, the protein quality of a food must be measured. Established methods for the measurement of protein quality are few in number and usually quite expensive, the most common is a time-consuming biological assay. This latter method is used to determine the protein efficiency r ratio, of PER, and consists of feeding weanling rats a diet containing 10% of the test protein as the only protein source. After 28 days of feeding, the weight gain is measured and the PER is the weight gain per gram of protein consumed. The test could take as much as 45 days and costs for a single assay can run as high as $500. This makes this test impractical for quality control and regulatory control of food products, because of the time and expense involved. Our Meat Laboratory scientists have been working on a method for determining PER values which does not require a biological assay, a method which can be rapidly carried out and would be suitable for quality or regulatory control work. The method takes into consideration that when a protein is digested, all the essential amino acids must be available at the same time for building new protein. With the amounts of the essential amino acids present being a limiting factor in the building of the new protein, they have found that amino acid analysis data can be used to calculate PER values. The amino acid analysis is comparatively inexpensive, about $60-$100 per assay, and the analysis can be accomplished in 24 to 48 hours. Equations have been developed for predicting PER values from the amino acid analysis and present results indicate that such equations are useful for certain protein combinations. Thus, PER values calculated from these equations for meat products, and combinations of meat and dairy products or meat and egg products correlated very well with the PER values found by rat feedings. Trials with combinations of meat or other products with beans gave poor correlations while meat or poultry with vegetables, vegetables alone, or dairy products were variable in their correlation. This line of research is being carried forward at present in an effort to develop a usable method that will apply to all products.

Following the goal of making better use of the products that we have, our Plant Products group has also been doing its share of conducting research on maple syrup. Only two countries, the United States and Canada, produce this commodity, and over 50% of the United States requirement of 2 million gallons is imported from our northern neighbor. The one million gallons produced domestically comes from less than five percent of the available sugar maple trees. In the past, our group has provided the farmer with new methods for the collection and storage of the sap and for the production of better syrup. One problem that has plagued the farmer is due to "buddy" sap, the sap that is collected as the tree begins to bud. This sap produces a very dark, off-flavor syrup with very little value. Our investigators found that if this "buddy" syrup is passed through an ion exchange column, the off-flavor is removed giving a normal tasting maple syrup. Also, some of the color is removed, resulting in a lighter colored syrup which is more valuable than the darker one. This technique allows a greater production of syrup with no increase in the number of trees tapped.

While we are on the subject of sweets, scientists in our Physical Chemistry Laboratory have been carrying our research on greater utilization of fats. Making use of a simple technique used by most chemists, that of fractional crystallization, they have been able to fractionate animal fats to give edible, useful products. Starting with tallow, the fractionation yields three components; each 100 grams of tallow giving about 15% of a solid fraction, about 65% of a liquid fraction, and about 20% of a semi-solid fraction. The solid fraction could be used as a thickening agent for vegetable oil in producing a margarine and the liquid fraction could be used as a salad oil. And we have found that the semi-solid fraction could be used as a substitute for cocoa butter in the manufacture of candy. It has the same melting characteristics and mouth feel of cocoa butter and costs only about one-third as much.

The Animal Fat Products Laboratory has also been conducting research on making better use of our agricultural commodities. Research has been carried out using inedible animal fats, greases and tallows as starting materials for chemicals, polymers, lubricants and lubricant additives and detergents. One of the first experiments carried out in high school chemistry involves the conversion of an animal fat into soap, a salt of a fatty acid, which is an excellent cleaning agent. One end of the molecule, the carboxylic acid end, is hydrophyllic. The other end, the hydrocarbon chain, has an affinity for dirt and greases. Soap, however, only works well as a cleaning agent in soft, hot water. In cold water, it dissolves slowly and in hard water it forms and objectionable scum of precipitates. And for this reason, soap has virtually disappeared from laundry and dishwashing detergents. Scientists in our Detergents group have been working on this problem: how to utilize soap in a detergent which will work under any conditions. And they have succeeded. They have prepared from tallow a class of compounds, called lime soap dispersing agents (LSDA), which prevent the formation of the scum, keeping the precipitate suspended in the water and out of the clothing. The LSDA also imparts improved cold water solubility to the detergent. Detergent formulations have been developed containing soap, LSDA, and silicates (the latter as builders), which compare very favorably with the detergents n now available. In addition, the tallow derived detergent is more readily biodegraded than the current synthetic detergents, thereby reducing the pollution load on our sewage plants and waterways. Our formulation is also free of phosphate, again a reduction in polluting effect and since our detergent is made from tallow, an annually replenishable agricultural commodity, it would help alleviate our energy crisis by freeing petroleum used in the manufacture of the synthetic detergents for other uses. We have also been investigating the synthesis of other useful chemicals or products from tallow. One of the first ideas was to introduce additional functionality into the fatty acid molecule and it seemed that ester interchange might be a useful route to the synthesis of isopropenyl esters, an unusual enol ester. Isopropenyl acetate was reacted with the fatty acid, in this case stearic acid, in the presence of sulfuric acid at 92°C giving a 50% yield of the isopropenyl ester and 50% yield of anhydride. The research continued in an effort to find a better yielding procedure. Our scientists found that methyl acetylene, a commercially available wastegas derived in the manufacture of butadiene or styrene, could be reacted with fatty acid, in the presence of the zinc salt of the fatty acid, to give an excellent yield of the enol ester. The reaction was carried out under pressure at about 150°C. They also found that MAPP gas, a fairly stable, non-explosive mixture of methyl acetylene, allene, and propane, could be used in the reaction in place of the more costly pure methyl acetylene.

The enol esters have proven to be highly reactive compounds, ideal as intermediates in the synthesis of many different compounds. These esters do not react in the same manner as regular esters. In a standard ester, the carbonyl oxygen becomes the negative site. In the enol ester, the negative s site is on the methylene group. Transfer of a hydrogen ion from the alkyl portion results in the formation of a ketene and acetone, and it is the ketene which accounts for some of the reactivity and versatility of the enol ester. Thus, in the presence of HZ, the final product will be R-Ch_2COZ. The yields in this type of reaction are essentially 100%, for the acetone is formed as a gas and can be removed from the reaction vessel, driving the reaction to completion. Using HF or HCl, one can produce the corresponding acyl halide free from contamination by the reactants, or anhydrides can be prepared by adding the corresponding free acid. The reaction is especially valuable in preparing highly hindered compounds. Isopropenyl stearate can be used to acylate benzene or diethyl malonate in the presence of a suitable catalyst. It forms chelates with many metals. One possibility is that it could be used to extract copper from mine waste water, for the copper chelate is hydrocarbon soluble and can be extracted from the water. Then treatment with HCl destroys the chelate and produces copper chloride. The list of possible applications is still growing. As a step that could lead to commercialization of the process, our engineers have worked out pilot plant production of the isopropenyl stearate, including designing a continuous reactor.

Our Hides and Leather Laboratory has been utilizing chemical and related scientific means to produce better leather, to better utilize raw hides, to preserve the raw hides before tanning into leather, and to reduce the pollution due to tannery wastes. This group was the forerunner in the development of glutaraldehyde tanned leather, a leather with very good water and perspiration resistance. This development allowed the production of combat boots that would last longer than a few weeks in tropical areas and of golf gloves that would last the entire season or longer. This search for the means of producing better leather continues today with a process known as graft polymerization. Leather, being a natural material, does not have uniform thickness or strength. In graft polymerization, a monomer is added to the leather and polymerized, giving a permanent and irreversible bonding to the leather. And the properties imparted to the leather can be varied according to the type of monomer employed. Take for example, a simple chain polymerization on chrome tanned leather. The chromium atom is bonded to several protein chains of the leather, and the polymer chains form additional links to the proteins. This type of graft polymerization would give a highly elastic leather, one that would stretch well and return to its original shape. By increasing the polymer cross linking, we get bonding to protein chains and to the chromium atoms also, resulting in a stiffer, less flexible leather. And our preliminary results indicate that the graft polymerization does have a leveling effect on the leather, with the thinner and weaker portions taking up more polymer than the thicker and stronger sections, which in turn increases the amount of usable leather.

But before one can make leather, one must transfer the raw hide from the slaughter house to the tannery, and in some cases, the tannery is thousands of miles away from the slaughter house. Unless the tanning operation is carried out soon after slaughter, the hide will deteriorate unless it is preserved in some manner. Salt has conventionally been used as the preservative, each 100 pounds of hide requiring about 30 pounds of salt. Then before the tanning process can take place, the salt must be washed out of the hide, and the resulting brine becomes a pollutant. The extent of the problem can be seen from the fact that 374 million pounds of salt were used in hide preservation in 1972. Research instituted on this problem, which was begun several years ago, has led to a method for preservation of raw hides utilizing a treatment with sulfite solution. The hides are placed into an acidic sulfite solution, containing one pound of sulfite per 100 pounds of hide and acidified with an equal amount of acetic acid, The solution container can also be used as a shipping container, reducing the amount of hide handling that is required as compared to the brining technique. And an additional advantage is that the sulfite decomposes during the preservation period and very little remains to be washed out of the hide before the tanning step. Samples preserved for 28 days by this new technique have produced excellent leather and ongoing work has shown that hides can be preserved for over 10 months.

Most animals have hair, therefore, the hides must also be dehaired before they are processed into leather. The dehairing operation utilizes large amounts of sulfides and lime to solubilize the hair, producing an effluent that is high in these two types of compounds, as well as the degraded protein from the pulped hair. This type of effluent is responsible for as much as 75% of the total pollution load from the tannery. The high alkalinity of the effluent makes it very difficult to handle in sewage treatment plants or at the point source. But again, our scientists have found an answer. They have worked out a method of treating the effluent with activated sewage sludge microorganisms that have been acclimated to the highly alkaline lime-sulfide effluent. This process results in removal of 91% of the nitrogen and 90% of the sulfides.

From hides or parts of hides not coverted into leather, we have produced comminuted collagen, a food grade material made by chopping the collagen from the hide into fibers of various sizes, the final chopped size being determined by the use for which the material is intended. One of the uses might be as an immobilizing medium for enzymes, or the collagen might be used as a texturizer in food products. The material can absorb as much as eight times its own weight of water. As an example we have in one beaker the dry comminuted collagen, in a second water has been added and we have two phases. In a third, acid has been added and the water has been completely absorbed by the collagen. The product can be extruded and it will hold its shape very well, as illustrated in a fourth beaker.

Our chemical engineers have also made other contributions. About 20 years ago they developed a product that I am sure everyone here is familiar with, the dehydrated mashed potato flake. The development was really two fold: first, a method of cooking the mashed potatoes known as the "Philadelphia Cook" was devised; a method suitable for the production of flakes or granules; and second, the process to produce the flakes was worked out. This development occurred at a very opportune time--potatoes were in surplus and potato consumption had been decreasing. Many companies produced the product, the consumer liked the product, and the consumption of potatoes started rising. Also the process allowed consumption of surplus potatoes, yielding a product that could be more easily stored and used throughout the year. One improvement in the product has been brought about by its extensive use in the school lunch program. This program reaches children from lower economic levels, children who do not usually receive a well balanced diet. Our researchers proposed to fortify the potato flakes with Vitamin C and thereby provide the children with this vitamin in order to improve their nutrition. This was done, and over 16 million pounds of Vitamin C fortified potato flakes were used in the school lunch program in 1970.

Our Engineering group has developed another type of dehydrated product, explosive puffed vegetable and fruit pieces. Conventionally, vegetable and fruit pieces, such as carrot dice or apple slices, have been dehydrated by oven drying. As a piece dries, the outer layer becomes hard, the piece shrivels, and removal of the water becomes more difficult. Freeze drying does not result in a shrinkage of the piece, but this process is very costly, and certain items undergo undesirable changes when subjected to this method of dehydration. For example, carrot and potato pieces subjected to freeze-drying lose their color, resulting in an unappetizing looking product. With our process, the start of the dehydration process is the same as in the conventional drying process, but the drying process is stopped when an intermediate moisture level is reached, usually in the range of 20 to 30% moisture. The pieces are then placed into a "puffing gun", an apparatus very similar to the "puffing gun" used in puffing rice or wheat kernels, the gun is sealed, and the temperature and pressure are raised to a predetermined level. Then the pressure is released almost instantaneously. The remaining moisture within the piece flashed into steam, causing a slight puffing or expansion of the piece but more importantly, a honeycombed or porous structure is produced within the piece. Now, the piece is returned to a dryer for the final drying step, to 3-4% moisture, a step very easily carried out because of the porous structure of the piece. Making a comparison of the two types of products, we find that the conventionally dried piece requires about 16 hours drying time and takes 40-45 minutes of boiling to reconstitute and the puffed piece requires only 6-7 hours of processing time and reconstitution of the product is accomplished with about

5 minutes of boiling. As is readily apparent, the energy saving in producing the dehydrated product and in its reconstitution is considerable. This process has been applied to carrot dice, potato dice and slices, apple slices, blueberries and other fruits and vegetables. The Engineering group is now developing a continuous puffing gun, a piece of apparatus that would have a greater production rate and therefore a greater appeal for industry. In this apparatus, the puffing operation has been divided into two steps: the heating-pressurization step and depressurization step. The pieces are introduced into the heating and pressurization chamber, travel through the chamber and are transferred into the puffing chamber where the pressure is released. The puffed pieces are then expelled into the collector and dried.

Our microbiologists also contribute to the research program of the Center. All food items that we develop are checked for bacterial contamination, and research is conducted on possible sources of contamination of processed products, especially cured or processed meat products, by Salmonella, Staphlococcus, and Clostridium Microorganisms. To carry out this research, we have had to learn how to make various products, such as frankfurters, Lebanon bologna, or others, making use of the Meat Processing Laboratory. The bacteria under study are introduced at different stages of the process; at the grinding stage, when mixed, before stuffing into casings, or before cooking in the smokehouse. We are happy to report that our studies indicate that the processing conditions, i.e., fermentation, smoking, etc., have not allowed growth of pathogenic microorganisms. In fact, the initial count decreases or disappears altogether.

Another type of hazard is due to chemical coumpounds that are present in the agricultural commodity or that are added during processing. In recent years many articles have appeared in print concerning the problems associated with the use of nitrite salts in processed foods. Nitrite salts are chemicals that have been used for centuries in making cured meat products. It has been found that nitrite may react with some of the amines of the meats to form nitrosamines, some of which have been shown to be carcinogens in studies with animals. Although there has been no implication of any nitrosamine in connection with cancer in humans, the potential health hazard of nitrite has warranted investigation.

One of the first problems to be solved was to find a means to detect nitrosamines in cured meats and to determine the amounts present, amounts that are present in parts per billion range. Our scientists found the answer in a combination gas liquid chromatographic and mass spectrometric analysis. The product to be analyzed is prepared in a form suitable for solvent extraction, extracted with methylene chloride, the extract concentrated, and the concentrated sample analyzed by gas liquid chromatography using a flame ionization detector. Those samples that show peaks corresponding to nitrosamine standards are then analyzed by GLC-mass spectrometry for final confirmation of identity. In this way, we routinely detect and identify nitrosamines in concentrations as low as 2-5 parts per billion.

With this detection method available, our scientists could now determine the stage or stages in the processing that the nitrosamines were formed. For example, with bacon, it was found that a carcinogenic nitrosamine was formed during the frying operation, and generally, the higher the temperature of the frying, the greater the amount of nitrosamine formed. And we have looked into methods or means to reduce or prevent the formation of the nitrosamines. One method that seems to hold promise is the addition of sodium ascorbate to the product during processing resulting in an inhibition or reduction in nitrosamine formation. We have also been looking into using other additives as substitutes for nitrite, chemicals which do not form hazardous compounds. Work is continuing along these lines, with the final answer still in the future.

Scientists in our Dairy and Engineering and Development Laboratories have been moving ahead in the area of dairy product research. The Engineering group has developed a process to make a dried whole milk which can be stored at room temperature for about 10 weeks, or in a refrigerator for about 12 months, or a freezer for up to 3 years without developing undesirable flavor characteristics. It reconstitutes very easily, has an excellent flavor and all the constituents of fresh milk. The process, as developed by our engineers, consists of a rapid, low temperature evaporation of most of the water in a vacuum evaporator after which an inert gas is injected into the concentrate. This mixture passes into a continuous vacuum dehydrator where the gas expands and causes foaming of the concentrate as it is drying. The resultant product is friable and easily broken into powder. The powder is packaged, and here chemistry comes into play again, for the powder must be packaged so that there is no oxygen present. For this purpose we have been investigating the use of oxygen scavengers and canning under inert gases, techniques that can also be applied to other food products.

Consideration of milk brings us to the research being conducted on cheese whey, a byproduct from the manufacture of cheese. The production of cheese has been on an upswing in this country, as well as in foreign countries, and the problem of pollution from cheese whey has also been increasing. The extent of this problem can be readily seen since for every pound of cheese that is produced, we must dispose of about 8.5 pounds of cheese whey, a watery solution of lactose, protein, and minerals. Although the solids amount to only 6 to 7% of the cheese whey, in 1973, about 30 billion pounds of cheese whey was produced. The whey can no longer be dumped into streams and rivers, and if disposed of into sewers, the extra charge made by the municipalities is high. Some of the cheese whey is now used in food and feed, but this only accounts for 42% of the solids, the other 58% remains to be disposed of. We have attacked the problem in several ways; carrying out our research on removing and recovering the solids from cheese whey and returning pure water to the streams, finding more uses for cheese whey and finding uses for the recovered solids. For by utilizing the recovered solids, the costs of their recovery can be partially or fully recouped.

Reverse osmosis and ultra filtration were two of the techniques studies for the recovery of the solids. Both methods make use of membranes fastened to a supporting material and high pressures to separate the components of the solution. In fact, one can think of reverse osmosis as the limiting case of ultra filtration, where the holes in the membrane will let only water pass through. Therefore, we can tailor the separation by these techniques to recover all the solids in one batch and get pure water or fractionate the solids in several passes through the apparatus, finally reaching pure water.

We have been investigating how to put the recovered solids to good use. One route has been the fortification of foods with the proteins recovered from the cheese whey. Foods made from grain, such as macaroni and spaghetti, contain protein, but the essential amino acids are not present in the correct amounts to provide the best protein nutrition and thus it was thought that fortification of pasta products might be a good outlet for cheese whey protein. Our engineers obtained a pasta machine and they have been working on this problem. By raising the protein content of the pasta from its normal 12% to about 20% by the addition of cheese whey protein, they have also raised the PER from its original 0.7 to about 2.4, or about the equivalent of casein, which is used as a standard in the PER determination. The product is slightly blander than nonfortified pasta, but with the addition of sauce, there is no detectable difference in taste. Samples have been made on commercial processing equipment with good success.

Another outlet for cheese whey solids is in a cheese whey-soy flour drink that our Dairy scientists developed about 8 years ago. The product is a powder composed of a mixture of soy flour and cheese whey solids that is very easily dissolved in water to produce the drink. The PER of the mixture is about 2.2 as compared to a PER of 1.8 for soy flour alone and, the nutritional balance is very good. This product has now been produced for distribution to developing countries as a food supplement for young children to help reduce the effects of malnutrition of these children. In conjunction with the Agency for International Development, and other agencies, about 5 million pounds of the whey-soy flour mix have been distributed to countries in South America, Africa and Asia and preliminary results indicate the the produce is very well accepted.

Other groups have been working with the lactose that is obtained from the cheese whey, using it as a starting material for the synthesis of other chemicals and products, or hydrolyzing it to the monosaccharides to improve its sweetness. The hydrolysis of the lactose also serves another purpose. A large number of the earth's population, especially non-whites, exhibit lactose intolerance. They lack the enzyme, lactase, necessary to convert the lactose into glucose and galactose during digestion, leading to stomach and intestinal distress. To prevent this from happening, we are investigating the enzymatic hydrolysis of lactose in the freshmilk, in the cheese process, and in the cheese whey. The hydrolysis of lactose by the addition of lactase while making cheese offers several advantages. Normally, cheddar cheese is cured for about 9-10 months, and during this time the lactose that is left in the cheese is hydrolyzed. Our Dairy Laboratory scientists have found that the lactose can be hydrolyzed by adding lactase during the curding operation, and the cheese produced by this process cures in about 6-7 months or less. This shorter cure time should reduce the amount of controlled temperature and humidity storage facilities required by the cheese manufacturer, saving him 1.3 cents per pound of cheese per month. And the cheese whey produced can be used in many different foods without further treatment.

In the last work that I have reported we have a good example of how we are attaining our current goals: to make better use of agricultural commodities, to improve the nutrition of these commodities, to save energy, to reduce pollution resulting from the processing of these commodities, and to reduce hazards to health inherent in our agricultural commodities.

Thus, as you have heard, Chemistry, as well as other fields, continue to move ahead at the Eastern Regional Research Center to provide maximum utilization of agricultural products for the greatest benefit to each of us.

ACS – An Initiator and Coordinator for Chemical Education

Patricia M. Lemaire
Manager, General Educational Activities
American Chemical Society
1155 Sixteenth Street, N.W.
Washington, D.C.

Presented to a Special Session of the Forth-Third Two Year College Chemistry Conference, Penn Valley Community College, Kansas City, Missouri, February 7, 1975.

As you well know, the American Chemical Society is a membership organization with a total of nearly 110,000 members.

Because of the size of its membership, its position in the scientific community, and its past contributions, the Society wields considerable influence in many areas. The scope of society services is such that many of the suggestions received are for services or programs that already exist. We also get suggestions for services which have already been carefully considered by society committees and rejected for one or more reasons. When a truly new suggestion arrives, society staff directs the suggestion to one or more committees or either the ACS Council, Board of Directors, or both. Frequently staff members find it necessary to do further research on the suggestion, to collect statistics, prepare preliminary proposals, and contact and visit government officials, as well as determine the financial implications of the suggestion.

Ideas for new society programs originate from many sources; from members not involved in society governance, from members who are involved in society governance, from members who are involved in society governance, from staff members, and from outside influences such as government agencies or other societies.

Let's look briefly at several current projects or efforts, at how they began, and what was involved in their development.

1. Cooperative Education:

The industrial-academic interface has long been of concern to the society. Some of you may have participated in operation interface programs that brought together academicians and industrialists in one place for several days. However, cooperative education, where the student becomes a paid, productive employee, had never received any significant attention in the Society even though it has been a widespread practice in engineering education for quite some time.

ACS took its first definitive steps in this area in 1973, when at the Eighth Biennial Education Conference, Dr. L. Carroll King from Northwestern made a plea to the effect that the Society do something more to improve exchange at the academic-employer interface. He specifically recommended that cooperative education be used. Dr. King's arguments were sufficiently convincing that the conferees endorsed his concept. At the ACS Board of Directors meeting that summer, the Board Committee on Education and Students recommended that a Task Force on Work-Study Programs be established to study the potential of cooperative education in chemistry. In the fall, the Task Force was created by board action. The ACS President and Board Chairman appointed members to the Task Force with Dr. King as chairman, and established a budget for it. In December 1973, a two-day Task Force meeting was held. A survey of cooperative education in chemistry in the United States followed and a carefully designed conference was convened in December, 1974, to better gauge the interest of both academic and employer representatives in cooperative education.

Participants in the 1974 conference discussed many aspects of cooperative education, from the point of view of the student, the educator, and the employer. One of the conference recommendations was that ACS establish an Office of Cooperative Education. Conferees agreed that ACS could and should become active in coordinating and disseminating information on cooperative education programs at both the undergraduate and graduate levels.

Establishing a Staff Office of Cooperative Education would require outside funding. This means that a proposal must be developed, written, usually, by staff and reviewed and augmented by those groups within ACS that are concerned with Chemical Education. While the process of committee review and concurrance on such a funding proposal can often be long and arduous, it invariably produces high quality proposals.

2. The Multi-Media user controlled modes of continuing education projects:

In August, 1973, a new assistant director for education, Dr. Lowell Paige, was appointed at the National Science Foundation. One of Dr. Paige's first new programs dealt with continuing education for non-academic people. With its experience in continuing education, ACS was one of the first to be appraised of the new program. Ideas for several ACS projects were discussed with NSF officials and two of the ideas were enthusiastically received. Quickly, appropriate ACS Committees were alerted to the new NSF interest and staff was encouraged to prepare a preliminary proposal. When the preliminary proposal was favorably received by NSF in March, 1974, a short deadline was set for receipt of the official formal proposal. Necessary committees were convened at the April 1974 ACS National Meeting, and they requested that a special group of experts in the various media areas be assembled to react to the proposal before a final formal proposal was completed. This was accomplished, and the proposal was drafted, reviewed, and submitted to NSF on April 19, 1974.

Thus, when circumstances demand, the ACS committee structure can and does permit a degree of haste, while still providing for maximum input from society members.

3. Recommended guidelines for the pre-service and in-service training of secondary school chemistry teachers:

The teaching of chemistry in secondary schools continues to be a matter of broad concern. The influence of the high school chemistry curriculum projects of the 1960's has produced better prepared students for college work in chemistry. However, a large portion of the secondary school students avoid these courses or fare poorly in them. Many colleges, particularly two-year colleges, must give a Beginning Chemistry course designed for students whose inadequate background suggests a likelihood of failure in the General Chemistry course. Not only are relatively few high school chemistry teachers ACS members, but surveys indicate that in many cases, especially in smaller schools, chemistry is often taught by persons with very little formal training in chemistry.

This concern pronpted the Committee on Chemical Education to recommend the development of guidelines for the pre-service and in-service training of secondary school chemistry teachers. The National Science Foundation reacted somewhat cooly to the funding proposal for this particular project. The Committee on Chemical Education, however, felt that development of such guidelines was important enough to receive ACS funding. A revised proposal was submitted to the Board of Directors, who voted at the last national meeting in Atlantic City, to support the project. Preliminary work on developing these guidelines will begin in the very near future.

4. Career Film, "The Chemist":

The increasing interest of students and educators in career education has prompted a re-evaluation of the ACS career literature and career guidance effort. The idea to produce a new career film about chemists was approved and encouraged by ACS Education Committees and the Board of Directors has recently voted money to support initial development of the film. The purpose of the film would not be to recruit students into the chemical profession but rather to stress the value of the study of chemistry regardless of career plans: to give a realistic picture of the characteristics and qualifications needed by a person who does intend to go into chemistry; and to illustrate the subjective aspects of the profession--attitudes, personal relationships, and professional obligations. A Steering Committee for the film will be appointed soon.

5. The Two-Year College Chemistry Conference:

Some of you are well aware of the history behind the 2YC$_3$ and the work required to prepare for each of the conferences. Here again, the need for such conferences was perceived by an individual, in this case the organizer per excellence, Bill Mooney. Working within the Division of Chemical Education, the conferences were started on a once per year basis, grew until a proceedings could be published, and then expanded to several conferences each year both in the U.S. and Canada.

Many other examples can be used to exemplify the methods by which ideas can be nurtured into useful programs or services within the ACS. Much can be said about the idea whose time has come. But in the ACS, chance plays only a small role. If the idea has a sound basis and is financially feasible, ACS Committee and Staff structure can add further strength to it. The ACS is a voluntary society. Its greatest strength has always been in its members, who have given and continue to give, their time and energies to create, develop, and implement new programs in Chemical Education.

A Career Workshop in Chemistry

Joanne Harrison
Vincent Sollimo
Burlington County College
Pemberton, New Jersey 08068

Presented to a General Session of the Forty-Fourth Two Year College Chemistry Conference, Manor Junior College, Philadelphia, Penn. April 4, 1975.

This article describes a "Career in Chemistry Workshop" which was a result of joint efforts of a Student Development Specialist and the Chemistry staff at Burlington County College.

At Burlington County College, the workshop idea grew out of an interview with the career college counselor by a journalist with the local newspaper. The journalist was concerned with the type of career programs run by the college and at one point asked if the college ever ran summer workshops to help high school students become more aware of these career opportunities. What followed has proven to be a very exciting partnership between the counseling staff and faculty to meet the career development needs of county students and the development of the career programs at the college.

This workshop was a one week, concentrated program to increase the level of career awareness in the subject area of chemistry which included careers in allied health, environmental science and chemical technology. The workshop, designed for secondary school students (grades 9-12), provided career exploration experiences for both two and four year college programs.

It is estimated that the average worker will change careers three to five times in his or her lifetime.[1] Certain to be among the reasons for career changes are a lack of prior familiarity with the nature of the career, its daily demands and the opportunities within the labor market.

Two publications recently reported attempts to offset this problem. These resulted in a summer career workshop for high school juniors and a course of study designed for middle school students.[2,3]

The Problems

Burlington County College's enrollment in "Career" programs was well undersubscribed in light of the number of job opportunities that these programs offered.

Students did not realize the real opportunities of these programs and had little knowledge of the nature of work for which they could be trained.

Students tended to choose the liberal arts or a transfer program when they were not sure a career program was "right" for them.

Frequently students interested in career programs such as electronics, drafting or chemical technology were discouraged because their high school work had not prepared them for the first semester program requirements. This lack of high school preparation caused them to enter "out-of-step" thus requiring three years to complete the program, due to their development needs and the program's course sequencing.

Many transfer areas offered few employment opportunities, such as Liberal Arts and Education. There was a need for women students to realize alternatives to the traditionally accepted fields for women.

A basic realignment of enrollment was needed to ensure students better employment possibilities after the completion of their program.

Some of these realities undoubtedly sound familiar to many, especially to those working in community colleges.

In order to address these problems, the student development staff developed a proposal for career program exploration workshops, to be run jointly by members of the counselling staff and the faculty in various career program areas. Due to the time and budget constraints of the mid-year proposal, it was decided to run a pilot program this summer with one career cluster (chemistry careers) and to expand the program the following year if it proved successful.

Workshop Goals

The goals established for the workshop were:

1. To familiarize students with the potential of the career program.
2. To recruit students into a career program.
3. To motivate students to choose appropriate high school courses in order to avoid scheduling problems in college.
4. To provide the ingredients for better career planning and decision making in order to perceive broader alternatives.
5. To expose students to actual experiences, such as
cussions with professionals in respective care
and hands on activities including relevant
tory investigations related to various ca

Through discussion between the counselor and the chemistry faculty, it was decided that in order to be successful, the workshop should include interesting group activities, informal interaction with enthusiastic resource persons, a variety of concrete obviously related laboratory experiments, and at least one well-planned field trip where the student could respond to the real workworld. The workshop was to be run as an intense, one week small group workshop. The keywords in planning were MOTIVATION, ACTIVITY, INVOLVEMENT, INTERACTION, and EXPERIMENTAL. There was constant attention to the affective, as well as the cognitive goals.

The Career Development Activities

The entire workshop was a career devleopment experience. The format included both career exploration activities developed by the chemistry faculty and career exploration activities developed by the counselor involved. The counselor participated in all activities.

Counseling Activities

The goals for the counseling activities were:

1. To explore with each student their own particular direction--where they were at the moment--what alternatives they are presently considering, and what they perceive they will need to develop their career planning.
2. To familiarize the student with the process of decision making.
3. To familiarize students with the factors influencing career choice.
4. To help the participants to become more self-aware.
5. To expose the students to the wide variety of career exploration materials.

Methods

All the goals were approached via small group interaction, and discussion mode. The brainstorming technique was utilized in the development of the decision making model and the identification of the factors for consideration in career choice.

Value clarification exercises and self-assessment activities were used in the second session in order to facilitate self-awareness. Time for the discussion of individual concerns was provided and the Hall Occupational Orientation Profile was administered and interpreted in dyads and the small group.

The career information specialist prepared a very comprehensive packet of career materials for each participant on a wide variety of careers having chemistry as a base. This packet was distributed during the orientation to the career center at Burlington County College.

Chemistry Activities

The goals for the chemistry activities were:

1. To familiarize the student with the various options available in chemistry related careers such as allied health, environmental science and chemical technology.
2. To involve the students in relevant and successful laboratory experiences in the above mentioned career areas.
3. To create a favorable attitude towards a career in a chemistry related area.

Methods

The chemistry activities scheduled during the five day workshop focused on three areas: allied health, environmental science and chemical technology. These activities followed a format which included a one hour orientation to a career area usually given by visiting professionals and follow up lab activities related to the career area.

A complete schedule of counseling and chemistry activities is shown in Figure 1.

The allied health orientation, typical of other career area orientations, was conducted by a team of allied health spcialists from nearby Deborah Hospital. The team consisted of a doctor of respiratory diseases, a pharmacist, an inhalation therapist, an X-ray technician and a nurse. Discussed were topics such as the educational requirements in terms of courses and years, working conditions, job opportunities, salary and human interest insights peculiar to each area.

Following the orientation were the student involved short and relevant chemistry experiments in allied health.

The nature, length and complexity of the laboratory activities were selected on the basis of the student, background in chemistry--none was assumed--and how the students would relate the experiments to their own experiences. The lab activities were purposely kept short, about twenty minutes each, to permit students to complete a variety of exercises, thus increasing the probability that students would find some experiments very meaningful.

WORKSHOP SCHEDULE

DAY	TOPIC	ORIENTATION	LAB ACTIVITIES	CAREER ACTIVITIES
Monday	Allied Health	Deborah Hospital Staff	Polyunsaturation, Oil of Wintergreen, pH and Buffers	Orientation of Workshop
Tuesday	Environmental Science	Staff of Schuylkill Valley Nature Center (SVNC)	Field trip to Rancocas Creek	Self awareness activities value clarification activities
Wed.	Environmental Science	Nuclear Power discussion and AEC film	Half Life of a Ba-137, Thermal Pollution	Field trip to SVNC in Philadelphia
Thurs.	Chemical Technology	Slide presentation and discussion	Mirror Image Molecules, Analysis of Copper solution, Nylon and Polyurethane	Interpretation of the Hall Occupational Inventory orientation to Career Resource Center
Friday	Alyea Day	Dr. Alyea's Presentation	Armchair Experiments	Workshop Evaluation

Following is a brief description of the chemistry lab activities of the workshop which represented about half of the students time involvement in the workshop. Also included is a description of the field trips and presentations.

Polyunsaturation

The rationale included the hypothesis that unsaturated fats are related to cholesterol blood levels and heart disease. Using a bromine in carbon tetrachloride solution students determined the degree of polyunsaturation in solid and liquid fats. With the use of a simple formula relating drops of bromine solution used to %unsaturation the fats were ranked in order ot unsaturation. Commercial liquid and solid fats such as Crisco, Wesson and Mazola were used here.

Preparation and Analysis of Oil of Wintergreen

After preparing oil of wintergreen, students with the aid of a staff member, ran an infrared spectrum of a pure sample. Students quickly noticed the similarity of the spectra.

pH and Buffer

After determining the pH of common substances such as milk, seven-up, aspirin solution and orange juice using pH indicator paper, students compared the results with those using a pH meter. The properties of a buffer solution were investigated by titrating water, an acid solution and a buffer solution while monitoring pH. Graphical analysis led students to conclusions regarding buffer action.

Nuclear Power

After a brief discussion of environmental concerns related to nuclear power such as disposal of fission products and thermal pollution, "A is for Atom" an AEC film highlighting the benefits of nuclear research to mankind was shown.

The experiments described below followed the above orientation.

Half Life of a Radioisotope

Using a scaler, timer and semi-log paper students easily calculated the half life of Ba-137 with a minimum of staff guidance.

Thermal Pollution

To demonstrate the decrease in solubility of air in water used to cool nuclear reactors, students were asked to titrate 7-Up at various temperatures The amount of carbonic acid in soda is related to the amount of dissolved carbon.

Environmental Miniexperiments

After a comprehensive orientation to environmental science by Dick James, executive director of the Schuylkill Valley Nature Center in Philadelphia, students were led through a series of investigations on the Rancocas Creek which borders our campus. Students, after colllecting samples of creek water, conducted tests for iron, BOD,phosphate, pH, turbidity and caliform. Creek bed samples were examined for animal life.

Analysis of L and D Carbon

As a comparison between complex chemical instruments and the human olfactory system two compounds consisting o mirror image molecules were subjected to infrared and gas chromatography analysis. Both analysis indicated no difference in the samples since their simple chemical and physical properties are identical. (Students were unaware of optical rotation properties). Students could easily detect the difference using the discriminating power of the nost.

Copper Solution Analysis

With the use of a calibration graph and visible spectrophotometer, students determined the concentrations in parts per million of copper in water for several unknowns.

Synthesis of Nylon and Polyurethane

Perhaps the most "fun" experiments involved making nylon, about ten feet of it in some cases, and polyurethane. Students were encouraged to release their artistic talents in making unusually shaped objects.

The final day of the workshop was Alyea Day. Dr. Hubert Alyea, nationally and internationally known for his excellent chemistry presentations, highlighted the workshop with his timeless and fascinating demonstrations which were interspersed with humorous and philosophical anectdotes. He was received most enthusiastically. Dr. Alyea followed his presentation by leading the students through several of his armchair chemistry experiments done using his self contained laboratory kit. Students were given a kit and armchair manual as compliments of the college.

Summary of the Attached Student Evaluation

The students were asked to complete a workshop evaluation instrument. A rating scale ranging from one (1) to five (5) was used to evaluate the workshop activities.

The evaluation was positive throughout with no scores less than 3.0. The area of the workshop that the students felt most positively about was the helpfulness of the workshop coordinators and resource persons as well as the enjoyable nature of laboratory activities. The narrative comments also reflect this response. Personal responsive attention was a most valuable part of the experience.

Generally, the career development activities were scored about .5 lower than the science activities. We believe this is because the former involved more abstract exercises than the latter which were more concrete. An attempt to develop more concrete exercises for this area is recommended.

The overall evaluation, with the exception of the time schedule, was 4.6 which indicates that the workshop generated a great deal of positive feelings towards Burlington County College. The question about the convenience of the time schedule totaled the lowest overall score and this would indicate that effort should be made to find a more convenient offering pattern. Phone conversations from numerous potential participatns also indicated the timing was poor (July 8-12, 1974) and it is believed that this was one of the major factors for the small application rate.

On the basis of the student evaluation of this career workshop the authors believe that such an activity provides an excellent service to many students, some of whom contribute to the college attrition rate because of the lack of adequate career information. Future plans are to expand these workshops to include career workshops in other areas such as the social services, business and the humanities.

Implications of the Evaluation are:

1. Keep workshop activities as concrete as possible
2. Allow for plenty of personal interaction between coordinators, staff, students, and other resource persons.
3. Seek to find a convenient time pattern possibly other than a summer term.

Unique Aspects of Workshop

A most unique aspect of this workshop was the valuable partnership of the counselor and the academic faculty in the development and implementation of the experience. This partnership afforded the opportunity for the counselor and faculty to see one another in action and thus break down some of the role stereotypes that often exist. The counselor's participation in the entire experience helped to facilitate the group process especially during the presentations by resource persons, and it was a valuable means for the counselor to increase awareness of career opportunities, the nature and demands of the work setting and the personal requirements of various opportunities.

The experiential activity oriented approach facilitated the achievement of the affective goals.

The focus on the cluster of careers growing out of chemistry such as medical and allied health careers, environmental science careers, chemical research and technical careers was most appropriate for students, especially at that point in their career planning. The majority of the students were sophomores and juniors and their goals were still very broad as the probably should be.

The combination of presentation, hands-on labs and self- and career-awareness activities, worked out well as it provided the students career information, involvement in work related tasks and a system for considering their alternatives.

Recommendations

To insure a successful experience for participants the number of participants should be small. We recommend a maximum of fifteen students for optimum student-staff involvement. We feel this size will provide better student-staff rapport which will result in a favorable participant response.

The student fee for the workshop should be a nominal fee such as five or ten dollars. Any expenditures above student fee total should be supported by the division or via other means such as individual or professional society support.

Advisory committees could be instrumental in generating workshop scholarships for students.

The workshop activities should be as experiential as possible. This means hands on experience, personal involvement, relevant and concrete types of activities.

Resource persons invited in as presentors should be carefully screened to ensure that they are enthusiastic, informative, and interesting.

The counselors should be involved in all the activities, not only the counseling-career activities. Teaching experiences break down counselor-teacher barriers and establish a better understanding of both the counselor's and the teacher's role.

Both counselor and faculty member should articulate respective activities jointly.

The authors would like to thank Kathleen Harter, Fred Nicolai and Barbara Stewart of the College Chemistry staff for their ideas and assistance.

Anyone desiring additional information about this workshop may write either of the authors at Burlington County Community College, Pemberton, New Jersey 08068

CHEMICAL TECHNOLOGY

The Chemical Technologist in Canada's Future

T.H.G. Michael
The Chemical Institute of Canada
151 Slater St., Ste. 906, Ottawa, Ontario K1P 5H3

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I must apologize for the use of such a title for an address to an audience composed of many from the United States. My reason of course is that I am not very familiar with conditions in this field in the States. I hope that I may have a better understanding of the Canadian picture. I hope too that the Canadian viewpoint may be of some interest and relevance to our very welcome visitors from the south.

The chemical technologist is a relatively new arrival on the Canadian scene. For many years there have been institutions in many parts of Canada which have trained chemical technicians. Central Technical School in Toronto, for example, has offered such a course since at least the 1920's. There have also, of course, been Canadian universities which have offered training in chemistry at the bachelor degree level since the early years of the century, and even before. But the chemical technologist has only been formally trained as such in Canada since the 1950's, with the Ryerson Polytechnical Institute in Toronto being a pioneer in the field.

I am not going to give a rigorous definition of a chemical technologist today, even if it is possible to do so. In order that we can all be sure that we have the same sort of person in mind, I will say, however, that The Chemical Institute of Canada recognizes as a chemical technologist a graduate from a three year post-secondary school course, starting after Ontario Grade 12 or its equivalent, and which has at least 2400 hours of classroom and laboratory work in chemistry and cognate subjects.

The phrase "chemical technologist" is thus used in a special and limited sense. The public press tends to use the word "technologist" as synonynous with "specialist" or as a word descriptive of anyone with specialized skilled training. In such generalized usage, a chemical technologist might be anyone from a technician with the slightest training to a person holding a Ph.D. degree in chemistry. We are, of course, using the phrase in the restricted sense as loosely defined.

When chemical technologists first appeared on the Canadian scene, they came largely from two sources. The first were the unfamiliar graduates from the new post-secondary establishments. The second was a stream of immigrants from other countries, largely European, and with qualifications unfamiliar to Canadian employers.

In the decade of the 1950's, there was a major shortage of highly qualified manpower in Canada. The chemical and petrochemical industries were undergoing the major post-war expansion. The educational establishment was also rapidly expanding, but was not capable of producing enough of its product to meet the demand of the times. Thus industry turned eagerly to the supply coming from other countries. The unfamiliarity with European training methods, levels, and nomenclature resulted in a lot of confusion. It is easy to understand that in such times of shortage it was readily possible to expect a higher level of training than many immigrants actually possessed.

Canada had done very little in the way of developing part-time, sandwich or cooperative courses up to that time. Consequently the graduates from such types of training were ignored or down-graded in some instances. In others, they were endowed with qualifications and qualities far above those which they actually possessed.

In much the same way, the graduates from the new Canadian post-secondary establishments had difficulty in establishing their true competence.

This confused and complex situation was one of the major reasons for the establishment of the technologist certification plan by The Chemical Institute of Canada. For employers it provided a means of assessment of unfamiliar qualifications. For the individual, it provided a means of finding out what his education was equivalent to in an unfamiliar country, and an idea as to what type and level of employment he might expect to find.

in Canada, almost as much as in the United States, the university degree was the goal of those seeking education as a means to employment, throughout the first half of this century. Linked to this was the social acceptance of the university graduate, and inversely, the lack of acceptance by society of those who did not possess such a qualification.

One of the [illegible] and major hurdles to be overcome by those responsible [illegible] the new post-secondary educational institutions was this [illegible] acceptance by society.

A second major problem was the lack of flexibility in and between the educational streams. This is a problem that has not been properly solved yet. How to give adequate credit for achievement in various type courses, when an individual, for whatever reason, transfers from one to the other, is a most important question.

In the more recent past, the employment picture has been full of seeming paradoxes and unsolved problems. The rapid shifting of popular views during the opulence and prosperity of the sixties led to a decrease in the number of students studying chemically oriented fields in the universities. This in turn led employers to turn to those trained as chemical technologists. The employers found that great strides had been made in this type of education in the previous decade, and that the person educated in this way had his own standards and field of usefulness.

There has been a gradual acceptance of the chemical technologist in Canada. This is not to say, however, that all the problems have disappeared or have been solved. Perhaps it is useful to list the problems still facing the new chemical technologist, and also those who are responsible for educating and producing these persons:

(1) The lack of complete acceptance of technologists.

(2) A lack of understanding on the part of potential employers of the ability and capabilities of technologists.

(3) The impediments to mobility between technologist and chemistry or chemical engineering bachelor streams.

(4) A feeling on the part of some technologists that their training is equal to or better than that possessed by university honours graduates.

(5) The inability of many persons to distinguish between technologists and technicians.

The role which the chemical technologist will play in the future depends greatly on the solutions which are found to these problems. The role also depends to a great degree on the economic climate which may exist in Canada and indeed North America. If we have the major industrial expansion which many are predicting in the chemical, petrochemical and energy source fields, then the future for chemical technologists is bright indeed. If on the other hand we are entering an era of continuing galloping inflation, political insecurity, and a general decline of Western institutions, the future for technologists is as bleak as that for all highly qualified manpower.

Those who are following the signposts of Canadian economic development are predicting that the development of the fossil fuel sources existing in Canada will proceed at a rate over the next decade which we now consider fantastic. They predict that the factors which will limit this expansion are not financial nor material. Rather, the limitation will be the availability of skilled manpower, particularily chemical engineers and the trades relating to welding and fitting. Such a situation will of course lead to a major increase in demand for chemical technologists, and to a major utilization of their capabilities.

As is often the case, the true path will probably lie somewhere between these extremes. In such a situation, the series of problems which I listed remains of great concern to the educators of technologists. It is worth stressing that these problems are not technical. They are educational and sociological in the broadest sense. They will require united and continued action in order to solve them in the interests both of the technologists and of the communities in which they work.

How is The Chemical Institute of Canada contributing to the solution of these problems?

Its first major step was the creation of the certification plan for chemical technicians and technologists. This had the effects of setting national standards for training, of publicizing the chemical technologist, and of providing an evaluation service for both individuals and employers.

Its second and most recent activity has been the establishment of the Canadian Society for Chemical and Biochemical Technology. This is a constituent society of the CIC. Its members are all CIC members, and are entitled to all the services and privileges of The Institute. This Society will provide a focal point for the activities of chemical technologists. It is hoped that it will provide technical programming of interest and value to technologists. It will do this on both a national and a local basis. The C.S.C.B.T. will also initiate activities designed to meet the needs of the chemical technologist as a member of a unique profession.

The Chemical Institute of Canada is attempting to provide programs and services which meet the needs of all practitioners of chemistry in Canada. Some of the activities include meetings, sessions, development courses, insurance programs, publications, salary surveys and recommendations, employment services, awards and recognition, and many more. Whether an individual is a teacher, an economist, a production man, a researcher, an executive, a technical sales person, or a student, the CIC wants to provide both the technical and the professional programs and services which he needs. The C.S.C.B.T. will do this for the technologist, and in so doing will integrate him into his rightful place in the chemical community.

Forensics in a Police Science Program

Robert G. Tyndall
Durham Technical Institute
Durham, North Carolina 27703

Presented to a Symposium of Chemistry Related to Careers at the Forty-Third Two Year College Chemistry Conference, Penn Valley Community College, Kansas City, Missouri, February 7, 1975.

Police Science Technology or other two-year law enforcement programs are not brand new, but have their origin in federal and state supported programs of the late 1950's and early 1960's. During that time period as urban areas were rapidly growing in population, the need for larger, better trained, and better equipped law enforcement agencies became apparent. The technology of crime detection and prevention had been expanded as a result of war research; yet, many municipalities were restricted by the lack of adequate laboratories, lack of communications networks, and lack of trained personnel. Often then, as now, in many areas, materials and samples collected at crime scenes were inordinately delayed in their progression from the field to qualified testing facilities and then back to the investigating agency. In addition, upon evaluation, much evidence was and is overlooked at crime scenes because of poorly trained personnel. What then was and is being done to improve this situation?

Beginning in 1962, a Law Enforcement Training Study Committee was appointed to develop in North Carolina a model training program curriculum in cooperation with the Industrial Education Center in Winston-Salem, North Carolina. As a result of numerous meetings in late 1962 and early 1963, North Carolina began to improve its law enforcement base with local and regional workshops and training institutes sponsored through the state Industrial Education Centers.

Durham, a city of about 100,000 and located at the approximate geographical center of the state, adjacent to the famed Research Triangle Park, had its first law enforcement course offered in 1966 by the local district attorney at Durham Technical Institute. The fall of 1968 saw the establishment of a full two-year program at Durham Tech under the leadership of Joe Wade. The first ten full-time police officer-students were to be awarded, upon completion of the program, the two-year Associate in Applied Science Degree in Police Science Technology. Following our lead, three other technical institutes of the fifty-seven North Carolina member schools now offer the two-year AAS degree in Police Science: Sanford Tech, Technical Institute of Alamance, and Wake Technical Institute. Other inservice workshops are held across the state.

From 1968 to the present, our enrollment has jumped significantly. This fall there were one hundred seventy enrollees distributed between the home campus and four local police stations: Burlington, Chapel Hill, Carrboro, and the Durham Police Department.

Although forensics as a separate discipline has not been offered at DTI, five Police Science courses have as their major thrust some elements of forensics. The five courses, each carrying five quarter hours of credit are: Criminal Evidence, Criminal Investigation, Introduction to Criminalistics, Fingerprints and Photography, and finally, Chemistry. It is with the latter that I became involved in 1972. Our teaching divisions are divided such that chemistry, at present falls under the Division of General Education. As it is my belief that occupational and terminal education programs should be as functional and applicable as possible, it became my task to find out as much about the chemistry of law enforcement as possible.

Classical academic training, unfortunately, does not train persons, in general, for such specialized areas of application. As a result, little time was lost in gathering information from the few library resources we then had available and from local, regional, and federal information offices. Nevertheless, the crucial questions became: What is the average background of entering students; What is their qualitative and quantitative ability; At what level can they best be taught; Is chemistry a required part of their background; and What in modern chemistry applies most appropriately to a Police Science Program? These were and are not easy questions to answer; yet, each of you has had, will have, or should have attempted to answer them for your programs. Your main guiding force should be grounded in the philosophy and purpose of each of your respective institutions and what specific objectives each of you have or may set for your law enforcement program. Do not, by any means, forget to avail yourselves of local and regional resources in arriving at specific objectives for your program. This may be accomplished through a Board of Advisors or the typical advisory committee found in many educational institutions. A functional, well-integrated program cannot be run without the full cooperation of local law enforcement agencies, the respective State Bureas of Investigation, and any federal agencies that may assist with resources or personnel.

In a North Carolina court case (Green vs. Kitchen, 229 NC 450 (1948)), the following statement is made:

> "Poets may be born, but policemen must be made...a city...cannot convert a neophyte into a policeman...by the simple expedient of investing him with a badge... and a uniform. Before one is fitted to discharge the duties of a police officer, he must know what those duties are and how they can be performed."

The present state of scientific criminology is a tribute to the ceaseless struggle of police officials and police scientists over the last twenty years. Today, it is a matter of accepted routine for the courts and law enforcement officers to seek the services of the local or state police laboratories whenever a question concerning physical evidence arises. The scene of a crime is no longer looked upon simply as a base for questioning witnesses. It may also be considered as a field laboratory site where traces of clue material can be discovered and made to give eloquent testimony at the trial. In addition, the multitude of detective shows on television have raised the perceived expectation of the public with respect to capability and ingenuity.

The function of the laboratory in police work is the scientific examination of physical evidence. Usually, the purpose of this examination is to determine the manner in which a crime was committed, to abrogate suspected evidence or connect a suspect with the crime. Also the lab aids in establishing the identity of the criminal. Naturally, the activities of the laboratory are not rigidly confined to these few objectives, but may include many other tasks which the multiple duties of police work entail.

By looking momentarily at the questions asked earlier, perhaps we can discover some guidelines based on our experiences. Since the entire N.C. Community College System is "Open Door", students holding a high school diploma or its equivalent may enter the various institutions. This means that the diversity of students entering may vary from a recent high school graduate to already employed police officers with many years of experience, who are seeking upgrading for position and/or salary promotion. In fact, fifty of our present 170 students are part time, additionally holding down full time, forty hour plus work seeks, often with "impossible" schedules. This necessarily taxes the flexibility of an educational system, but our role, in part, is to meet the needs of the community we serve.

The misleading public image of "dumb" policeman has not been substantiated from our experiences, yet the overall qualitative and quantitative aptitudes of enrollees in Police Science falls lower than that of other quantitatively based two-year technologies such as Electronic Engineering, Opticianry, Respiratory Therapy, or Business Data Processing. The limits this type of information may place on prospective programs must be analyzed at the institutional level and kept in perspective by the objectives of an individual program.

The level at which instruction may be aimed is a function of the normal routine of each respective institution. If there are generally mixed curricula classes where students from several disciplines are grouped, stratified teaching may be a problem. However, if class groups are generally discipline oriented, or taught using the more contemporary andragogical techniques, then the rate or depth of coverage may be tailored to the needs of individuals. After all, it is generally accepted that the Community College-Technical Institute setting is best equipped to innovate in the educational process. How well we are indeed fulfilling that image is the topic of much recent research.

Chemistry as structured for Police Science at Durham Tech might be characterized as an applied, non-major course. Because of the generally low quantitative abilities of Police Science students, the course is not theoretically or mathematically based. John Hill's Chemistry for Changing Times, first and now second editions, Burgess Publishing Company, has been a successful classroom text though none presently in print would be completely satisfactory. Hill's book allows a flexibility of depth and content after chapter six or seven which encourages student participation and interest expression. Of necessity, the first four to six weeks must be spent developing the classical areas as described in our catalogue: "Study of physical and chemical properties of substances; elements, compounds, gases, weights and measurements; concepts of metals, acids, bases, salts, solvents, solutions, and emulsions". Additionally, however, we focus beginning with the seventh week of our eleven week quarter on investigative chemistry, alcohols, poisons, heavy metals, proteins, drugs, fire danger, and chemical field or lab tests for forensics.

Student interest at this stage can often be a problem. Nevertheless, if one is clever to continually remind the student of the areas of law enforcement where chemistry is applied, signs of rejuvenation become apparent. Consider for instance these areas in general; photography, powder residues from firearms, blood analysis, intoxication level analysis, drug analysis, fingerprint development, document recovery and restoration, typing of blood, urine, saliva, and overall crime scene search and analysis. If an instructor can continually allude to a functional use of chemistry, law enforcement students can often be stimulated to undertake individual outside projects. The stimulus can generally be traced to the individual responsibilities or assignments of already employed law enforcement personnel. Consequently, it helps to know more about your students than their names. The student's "other life" is often the key to his intellectual, academic, as well as professional success.

In general, a well integrated forensic curriculum for law enforcement personnel should include an exposure and/or knowledge of: Chemistry, Firearms, Documents, Interrogation, Photography, Fingerprints, and Lie Detection. In particular the chemistry section will have three areas of primary concern: (1) Basic Chemical Analysis: (2) Micro-analysis: (3) Instrumental Analysis. Not all law enforcement agencies will have full capabilities in the above three areas, but a knowledge of their function is essential in a good program. As a baseline of information, examples of chemical analysis might include the following; (1) Determination of the identity and proof of intoxicants (2) Probing, indicating, designating and confirmatory reactions designed to identify unknowns (3) Examinations of contents of body organs, both qualitatively and quantitatively (4) Powder and primer residue examinations to determine whether suspect or victim has recently fired a weapon (5) Recovery of inflammable materials from debris, etc. usually recovered from the scene of incendiary fires or places where suspected arson has taken place (6) Detection and identification of urine and saliva. Other chemical section tests devoted to microscopy might be (1) Detection of blood, its identification by origin, and the classification of the human blood by the International Blood Group (2) Detection of seminal stains and spermatozoa in sex offenses (3) Identification and comparisons of animal, vegetable, and synthetic fibers (4) Determination of the structural characteristics and the condition of hair, its species of origin, and the identification of substances contained thereon (5) Comparison of glass fragments based on density refractive index and fracture patterns (6) Identification of Marihuana, other narcotics and illegitimate drugs. Finally, in the area of firearms and metals where a comparative stereomicroscope is available, the student might be exposed to the following: (1) the identification of firearms (2) The determination of such factors as direction, range, sequence of penetration, etc. (3) The restoration of such identifying devices as serial numbers, trademarks, etc., on metal evidentiary items; (4) The comparison and identification of tool impressions usually coming from situations of forcible entry. As one can easily see, the scope of this presentation does not allow coverage of all potential areas of concern. Still, I do hope what has been said can be put to good use at your respective institutions.

Chemistry for Laboratory Technicians

Stanley Cherim
Community College of Delaware Co.
Media, Penn. 19063

Presented to a Symposium of Chemistry Related to Careers at the Forty-Third, Two Year College Chemistry Conference, Penn Valley Community College, Kansas City, Missouri, February 7, 1975.

Having pursued a dual career of chemistry teacher and researcher in physical biochemistry for a period of eight years, I became aware of the value of laboratory technicians and the specific professional training that they need. It was often an extra responsibility of mine to train technicians in support of our research activities in Dr. Cyrus Greenberg's laboratory at Smith, Kline, and French Pharmaceutical Co., and at the University of Pennsylvania's Johnson Foundation for Physical Biochemistry in the laboratories of Drs. Britton Chance, Ronald Eastbrook, and Walter Bonner.

It quickly became apparent that laboratory technicians had to be infinitely more responsible, knowledgeable, and creative than the unfortunate bottle-washing stereotype. These technicians had to have a knowledge of basic chemistry and an understanding of what modern instruments measure and, in theory, how they work.

I have had occasion to read papers published in prestigeous journals, such as the Journal of Biological Chemistry for example, that were co-authored by prominent scientists and laboratory technicians. However, these technicians were, almost without exception, imported foreigners. They came from England, Germany, Holland, Belgium, Scandinavia, Australia, France, and Japan. I believe that the United States ought to be providing the kind of training that will produce technicians of similarly high caliber. We can produce such first rate technicians if we choose.

When in the Fall of 1968, the Delaware County Community College asked me to teach a course in Chemical Technology, i.e., Chemistry for Laboratory Technicians, I was delighted to have the opportunity. An immediate search for an appropriate textbook proved fruitless--there were none. The only alternative was to develop my own materials based on my experence in industrial R & D and pure research at the university. As the lecture notes took the form of book, I approached the W.B. Saunders Publishing Co. and with their wonderful support and encouragement my efforts led to the publication of my text, Chemistry for Laboratory Technicians, in March 1971.

On the basis of my more than 18 years of teaching chemistry and my experience in research I tried to compile a practical "how-to-do-it, and why-you-do-it" text and lab manual for the training of laboratory technicians, the emphasis being on those topics most relevant to the needs of the technician in the research laboratory. I will not mention the topics I consider critical for the chemical education of laboratory technicians and some rationale for my selections.

A thorough review of chemical mathematics and measurement so that the technician gains a familiarity with the metric system, units of measurement for distance, mass, volume, temperature, energy, and electricity, graph construction and analysis, and basic algebraic operations. The use of a slide rule and desk calculator needs to be considered in connection with exponential notation.

A review of basic chemistry is required so that elements, compounds, and change can be handled within the framework of the mole concept.

Of very special interest to the technician is detailed instruction in record keeping and protocol development. And a technician must know his way around a library if he is to be given the responsibility of making literature searches.

The importance of the topic of solutions cannot be overemphasized. When a technician is asked to prepare a certain volume of solution having a specific concentration (molar, normal, percent, or ppm) there can be no room for doubt. He must know how to do it from solid fragments, and by dilution of stock solutions. The proper use of volumetric glassware is essential to correct methodology.

The ability to cope with routine stoichiometric calculations is expected. This skill must be able to be expressed in terms of ionic oxidation-reduction reactions as well as the simpler types of equations. A thorough familiarity with modern systems of nomenclature, both organic and inorganic, must be assured.

Where radioactive tracer methods are employed, the technician needs some understanding and experience with nuclear reactions, measuring techniques, and safety considerations.

The continuing study of Organic Chemistry and Biochemistry is a *sine qua non* aspect of the technicians responsibility in the modern research laboratory. Although my approach to the training of laboratory technicians has a distinct biochemical bias, it is only because this is my own primary area of competence. With a well conceived laboratory program that is integrated with the text, my notion of what a technician should learn ought to serve the needs of any technician - biochemical or otherwise.

The instruction for instrumentation should be concerned with acquainting the technician with the variety of instruments commonly used in the research laboratory along with an understanding of what each instrument is designed to measure. Attention should be focused on the scientific principles underlying the functioning of the instruments so that the technician does not become a robot-like manipulator of levers and switches on some magic box.

Above all, my primary wish is that the growing implementation and acceptance of Chemistry Technician courses in our nation's colleges and technical schools will produce the people our laboratories currently have to import from abroad. And these people are the ones who will bring a new respect for the profession of laboratory technician and a large measure of human dignity to the technicians as professionals.

Development of an Environmental Technology for Water and Wastewater Management

V. Hildegarde Kramer
Meramec Community College
St. Louis, Missouri 63122

Presented as a Project of Two-Year College Instruction at the Forty-Third Two Year College Chemistry Conference, Penn Valley Community College, Kansas City, Missouri, February 8, 1975.

Most Junior Colleges, including those of the Junior College District of St. Louis - St. Louis County, are dedicated to the philosophy that a community college should offer career programs, as well as two-year college courses. Such programs should give students authoritative training, and jobs should be available for the graduates.

At Meramec Community College in St. Louis, a two-year curriculum in Environmental Technology leading to an Associate Degree in Applied Science is now in its third year. Presently it trains students for careers in the field of Water and Wastewater Management.

The curriculum developed slowly. In 1968-1969 grants from the National Sanitation Foundation permitted a member of the Biology Department and one from the Chemistry Department to take several courses in the Environmental Engineering Department of Washington University. Dr. Campbell, a biologist, who has his doctorate in Environmental Engineering, took the lead in developing the new technical program.

An evening course for employees of water and wastewater facilities was started in 1971. Its aim was to prepare the employees for the Missouri State Certification Tests. It was team taught by professional engineers and several MCC faculty members. This course has continued as a Community Service program.

Ad Advisory Committee composed of representatives from industry, and public health, water and air pollution control agencies were consulted as we planned course content. We also discussed job opportunities with them.

The St. Louis Metropolitan Area offers opportunity for the students to visit many different water treatment plants and laboratories. Relations with management personnel in these plants are quite cordial. We have acquired a 275 gallon Model Treatment Plant which the students will operate and monitor with laboratory tests.

The chemistry course attempts to develop understanding of the physical and chemical principles underlying treatment processes and the commonly performed laboratory tests. The methods are those of Standard Methods for the Examination of Water and Wastewater.

Some of the goals of the students in the chemistry courses are:

To become familiar with the common standard methods used in water and wastewater analysis.

To gain proficiency and accuracy.

To practice good laboratory housekeeping.

To be able to prepare accurate reagents.

To keep systematic notes.

To write clear reports.

To apply simple statistics to results of tests.

To gain insight into reaction of water parameters to various influences.

Of the first eight students who graduated in the spring of 1974, two are in their junior year at universities. The others have jobs related to their training.

WATER POLICIES FOR THE FUTURE, the final report to the President and to the Congress of the United States by the National Water Commission, which has published in 1973, states under the topic Qualified Manpower:

> "There is need to upgrade the technical competence of personnel now in water pollution control programs and to recruit better trained personnel into expanding programs. In the area of municipal wastewater treatment, three trends result in a need for trained manpower:
> More treatment plants
> Higher levels of treatment
> In some areas, reclamation of wastewater requiring higher levels of operational control.
>
> The EPA estimates that approximately 12,700 additional employees will be required to man wastewater treatment facilities proposed for construction.
>
> 16 percent for professional positions
> 65 percent for operators and maintenance workers
> 19 percent for administrative support
>
> It is believed, of course, that salaries in the field be competitive to attract a sufficient number of competent trainees.
>
> The EPA administers a broad education and training program in water pollution control, including programs of

undergraduate and graduate training.

The commission believes it is the height of fiscal folly to authorize the expenditure of billions of dollars for water pollution control without priority attention to the manpower resources needed to run them efficiently, The 1972 Act authorizes such programs, but funds must be provided to implement them if they are to be effective."

It is our belief that junior colleges can and should play a significant role in this important development.

CHEMISTRY FOR NON - SCIENCE MAJORS

Organic and Biological Chemistry for Non - Majors

John R. Holum
Augsburg College
Minneapolis, Minn. 55404

Presented as a Keynote Address to the Forty-Third Two Year College Chemistry Conference, Penn Valley Community College, Kansas City, Missouri, February 8, 1975.

When we agree to attempt to teach the esentials of organic and biological chemistry to non-majors in one short term, the wonder of it is that we aren't judged mentally unhinged. Perhaps an important reasons for coming together in a conference such as this is to reassure each other that we are not crazy. But that reassurance would soon fade if we did not from time to time think very hard about goals, standards, content, organization and level for such a non-majors course. My intent in these remarks is to share with you some thoughts about goals and standards, and as time permits, content.

What ought to be our goals in a short course on organic and biological chemistry? When I talk to my students about this I like to put it into behaviorial terms. I tell them that what I covet most of all for them is that this course will change their behavior! I want them to be able to function professionally as scientists, nurses, technicians or whatever far better after having taken the course than they are able at the start. One of the most distinguishing marks of the professional in any field is that he or she intends to be a student throughout an entire career. There are always new things to learn--new knowledge, new instruments, new techniques, new theory. The true professional doesn't have to be told to tackle what is needed to stay abreast of the field. To do that requires above all that we insure that these students develop a solid foundation in fundamentals. Hence, the goal, stated behaviorially above, inexorably informs us about both our standards and the content of our course.

Concerning standards, I believe we must insist that students go well beyond the understanding stage to some level where they know something. I sometimes use the analogy of a knot, a square knot, when explaining what I mean to my students. My first experience with a square knot was with a children's eycyclopedia. I studied the picture of the knot and the directions given for tying one. I soon understood the square knot; but I did not know it. To know it I had to practice it, tying it and retying it until even after a lapse of weeks I could still tie a square knot. If we do not ask our students to go beyond the understanding stage, we might well ask why we have asked them to take any trip into this subject matter at all. I do not mean to downgrade understanding; I mean to put it into perspective. They cannot know something unless they have first understood it. But the student who does not realize the difference between understanding something and knowing it is simply mistaken about being a student.

One question that sooner or later arises is, "How will I know that I know?" The answer depends on the specific topic itself. In the case of a fundamental term, however, a term such as atom, or ion, molecule, acid and so forth, I tell my students that they may not say they know these terms until they can actually write our a definition that is clear, concise and complete and can do so many days, even weeks after last reviewing the matter. It is not enough to be able to pick out one definition from four choices that seems to be correct, not any more than one can know that he knows the square knot by being able to pick out its picture from a set of four pictures of knots.

To ask students to know something will actually displease only a very few. It ought to be one of our auxiliary goals to keep those who are displeased from the sacred precincts of professional careers in the health sciences or anywhere in science, anyway. I think all of us here today would like to join forces with Prof. Steven M. Cahn, author of The Eclipse of Excellence, in opposing "the increasingly widespread acceptance among faculty and administrators of the fatal educational principle that a student should not be required to do any academic work that displeases him."

Having talked about goals and the importance of knowing something, we now turn to the question of content. "What shall we ask them to know?" The answer, of course, is partly a function of time, but it is also a function of our original goal--to change their behavior; to get them nearer to a position of being able to learn new things. The fundamentals do little help unless they are remembered. We are therefore concerned about remembered chemistry. It isn't so much what we wish them to know at the end of the term as it is what we want them to remember for a long time.

What do we want them to remember from a study of organic chemistry? Certain topics "go without saying," but wel'' mention them anyway. Basic principles of naming simple compounds; ability to recognize functional groups, these are two fundamental topics. Beyond that we ask, will it be important that they be able to write detailed steps for S_N1, S_N2, E_1, E_2 mechanisms or any of the others? I think not. Please do not think that I want these omitted. They are used to explain many things and in their terms we rationalize a large number of seemingly unrelated chemical events. We do not omit them, at least as time and local level permit, but we put them into our goal-related perspective.

Do we ask that they be able to work out the steps of a multistep synthesis from compound A to F? Again, I think not. It is altogether unlikely that they will earn their living as chemists dealing with such a problem. Again, please do not think that I want such problems omitted. They are pedagogically very useful (and fun). I merely wish to place this kind of problem into our goal-related perspective.

What kinds of remembered chemistry then do we want? Put most succintly (and indirectly) we want them to be able to look at a complex structure of an organic molecule and not turn pale! They should be able to examine a structure and make some judgments about both chemical and physical properties. Can it react with water? Can it readily accept a hydride "ion" (be reduced), or donate (transfer) a hydride ion (be oxidized)? Does it have a group that can neutralize acid or base? Will it likely dissolve in water? If it does, will it change the pH of the solution? In other words, we want them to remember basic chemical and physical properties for each of the important functional groups. That's not very dramatic, but it is surely basic. And it points up an emphasis that I think is not often made, at least not in instructional materials. The emphasis becomes a reagents' emphasis. What are all the functional groups (we have studied) that can be made to react with water? with an oxidizing agent or a reducing agnet? with ammonia (or ammonia-like compounds)?

The reagents' emphasis builds slowly and it becomes the final instrument of "polishing" before tackling biological chemistry. That is where the in course pay off comes. They soon encounter the structure of a triglyceride, to cite just an example. An enormous page-filling ogre of a structure lying there like the fossilized remains of some microcosmic alphabet soup stares them in the face. It's enough to make stout hearts miss a beat and a complexion turn pale. But not for our sturdy students. Just ask them now, "Will this be able to react with water?" With the reagents' emphasis they take a few seconds to do down a "memory file" on functional groups that react with water (to be hydrolyzed) and they spot "ester". "Sure, it reacts with water, it you can get this hydrocarbon-like monster into water!" Or they view with equanimity the structure of cholesterol. (Part of that equanimity comes from being reassured that they won't have to memorize it. I don't think that would be a very important part of their remembered chemistry.) "Will it dissolve easily in the blood stream, a large aqueous medium?" "Don't be silly," responds the student who by now is beginning to experience the peculiar joys of knowing something, "It's mostly hydrocaron-like, and that's why it comes out of solution in the blood."

We now are into biochemistry with the class, and we probably are running short on time. Prof. Ralph Burns (East Central Junior College, Mo.) shared with me something he does that I like very much. He talks with the teacher of physiology (or whomever) who will have these students next, and they coordinate their programs. We cannot teach everything, and we need not. Where there are following courses by qualified teachers (that is, by teachers who in this instance do understand chemistry), it is ideal to coordinate efforts. Where this cannot be worked out, then the problem remains. What from the whole field of biological chemistry ought we try to include? Certainly the basic structural features found among the molecules of carbohydrates (if only glucose, maltose and amylose), lipips (if only triglycerides), and simple proteins. From the chemists view point one does not "know" these substances until one can write representative structural features and, as a minimum, their reactions with water. Enzymes and the related terms should be included. After that, time truly becomes the dictator. I'd sacrifice nucleic acids if I had to in order to explain, step by step how the citric acid cycle works and how it related to the respiratory chain. (But I'd not ask them to memorize all those steps--at least not in a one term course.)

The points that I hope will be the "remembered points" of my remarks have to do with goals, standards and emphasis. I urge that our goal be that of helping the students along the trail leading to a lifetime of professional behavior; that our standards be such that students are expected to know something; and that our emphasis be on remembered chemistry. Within this framework and the available time we select the content of our course. May we all do this so well that our students, as they move into positions of leadership in education for the allied health sciences, know from experience how valuable chemistry is to that career.

Laboratories for Non-Science Majors - Luxury or Necessity?

Thomas Dunn
University of Michigan
Ann Arbor, Michigan 48104

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(1) We must ask outselves both what function science

serves and why any of us are interested or even fascinated by it? Many answers ranging from the pragmatic to the philosophical and since most of us might even be agreed on the former, I thought I might comment on my own version of the philosophical order and temporal continuity of order as an expectation and many of us never cease to be amazed by the rationality of physical phenomena *at our level of perception*. I believe, therefore that many who do not go into science, nonetheless, at some, often late stage in their intellectual development, arrive at a stage of real curiosity about this rationality - perhaps this is accentuated by their own studies on fields of humanities and social science in which the irrationalities have become overwhelming and they are even seeking momentary refuge - either personal or academic.

This having been said, it is necessary that any course we construct, should attempt to answer or exploit their curiosity and thereby allow them to see the purely physical and the social worlds in a greater sense of unity.

This comment applies even more basically to the structure of a non lab course, but I believe that it also underlies any approach to a successful lab course for non-science majors.

In what follows I will often use the phyrase, in my opinion and there may be many places where I do not actually say it, but you might be prepared to infer it. This topic is, I believe, as yet only in the "opinion" stage.

(2) I do not think it is possible to carry out any sort of lab program without a concurrent or previous theoretical course unless the "lab" course is simply a euphemism for an integrated or combined "lab-theory" course.

(3) In my opinion such a course must be conceived as a separate entity and not simply as a segment or part of a more extended sequence. I admit that it *might* be possible to violate this maxim, but I very much doubt it, because of 3 reasons:

(i) Because of the time problem the course cannot afford to concentrate on techniques and since it is a first course, it can neither inherit them nor attempt to instill them for future use.

(ii) The hierarchical structure is very different for a course of this kind and for one of conventional character - the previous point about techniques is just *one* example of these different hierarchical relationships. It makes about as much sense to force these into the same mold as it does to reduce Tolstory's novel War & Peace to a 90 minute movie.

(iii) The reason for such a course is so different that we hope for a different result in the experience of the student. I would emphasize what I have previously said in my various discussion and writings about this type of theoretical course that this is probably the *only* formal exposure which the student will ever have.

(4) It must be designed from a zero chemistry base - i.e. no explicit or implicit knowledge of chemistry implied and even a very poor knowledge and/or understanding of natural and biological science.

Despite our frequent protestations and published figures I continue to be horrified by the sometimes total lack of even elementary science training in high schools (or elementary schools...sometimes both!). There are many reasons for this but we don't have the time today to discuss them. One of the other aspects of this matter is the rejection syndrome brought on by over professional courses in many high schools (also seems to have peaked!).

Natural curiosity sometimes, even often, overcomes this eventually and this leads to the next point.

(5) The courses should not be designed with the freshmen in mind. My experience strongly suggests that it be directed to the junior in terms of intellectual content, perhaps J- or S+.

I make this point because I have found a very marked change in outlook between the students in their freshman and junior years (thank goodness) but in nothing else is it as clearly changed as in the capability and readiness for an understanding of the ideas of science. The other side of the coin is what the student is prepared to do in an extra curricular sense, to enrich the laboratory and/or class experience. Particularly also in the more leisured capability for introspective thought.

(6) The experiments and experience must very much be connected with the (macroscopic) phenomena of science and strongly coupled to everyday experience as often as possible. This may appear to be emphasizing the concrete at the expense of the abstract (IT IS) but, of course, this must not be carried to extremes. We professional chemists seem to forget at times that chemistry was a productive and fascinating subject even before the 1874 discovery "divinement" of the tetrahedron C atom or before chemical physics had been thought of and many aspects of the purely phenomenological part of chemistry are those which impact most upon our non-science students.

As a matter of fact, ideally, I prefer to commence with the macroscopic concrete, wander somewhat lightly into the abstract (microscopic) and return once more to the macroscopic in order to round off and relate the microscopic or more abstract parts of the experience.

Additionally, the time is seldom available to press the point much beyond the awareness stage, certainly not to the mathematical, which I would add as my next point.

(7) Almost complete non use of mathematics beyond some simple arithmetic and/or algebra. This is not done because the students are potentially incapable of understanding but

(a) because it is intimidating to many who have not used their math for quite some time and

(b) because it is not really necessary to achieve our goal which I think of, more in terms of awareness, appreciation and understanding rather than of the mechanics and techniques. The next point also follows.

(8) That all apparatus used should be as simple as possible since (a) we have no time for the student to develop technique or familiarity and (b) since we hope more to develop intellectual curiosity and this does not demand complex physical apparatus.

You might well say that such a stricture leads one to expect a course as simple in appearance as that in an elementary school nature study class, and to some degree I would say *yes*, but I would remind you of the famous (legendary? Apocryphal) Professor of Economics, who was asked why he gave exams which asked the same questions every year to which he replied, "But the answers are different every year."

Obviously, in this sense, topicallity helps the choice but the principles should never be subjected to it.

(9) It's less important that something be learned from every experiment as it is in the more hierarchically structured science course and this allows one to design *some* very open ended experiments - which may reach no conclusion *BUT* will generate much more sympathy with a non-science major's class than with a bunch of freshman science or medically bound students.

I strongly advise *SOME* hierarchical relationship however, in view of my first remark about motive ie. we must not lead the student into *excessive* frustration since many of them hope to gain some sense of order and continuity from the experience. This point of openendedness also leads to the next.

(10) The experiments should be extensible in discussion and interpretation as to be appropriate to the very much wider variety of both interest background and degree of intellectual inquiry which is found in such a group.

(11) The last point is the addition of something which will bring out recognition of whatever it is which distinguishes *SCIENCE* from the humanities and/or the arts. These are the concepts of variables and their control, the concept of spacial and temporal - experimental *reproducibility* of experiment. This is an ingredient which is frequently ignored in our standard science courses. IS chemistry the same *everywhere* and *everwhen*? This is what we assume, without ever pausing to consider the problem or the evidence. Connected with this is also the concept of error in science. Conjecture and refutation.

Thus, in many ways, the lab course would be "structured" so as to allow an awakening awareness of the real character and nature of scientific enquiry (including its philosophical as well as pragmatic aspects). It is in this way that, at the same time, the essential differences and unity between natural science and the humanities, arts and social sciences become apparent to the student and this, after all, is the objective of the course, in my opinion!

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